LIMNOLOGICAL ASPECTS OF THE BOSTAL RESERVOIR SAARLAND, FEDERAL REPUBLIC OF GERMANY

DISSERTATION

Zur Erlangung des akademischen Grades eines
Doktors der Philosophie
der Philosophischen Fakultät
der Universität des Saarlandes

Vorgelegt von

EDUARDO MENDES DA SILVA

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LIMNOLOGICAL ASPECTS OF THE BOSTAL RESERVOIR, SAARLAND, FEDERAL REPUBLIC OF GERMANY.

by

Eduardo Mendes da Silva

A dissertation submitted to the Universität des Saarlandes in fulfilment of the requirements for the degree of doctor philosophiae.

Universität des Saarlandes
Institut of Biogeography
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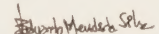
TAG DER LETZTEN PRÜFUNGSLEITUNG: 18.12.1985

DECLARATION

This work has not been accepted in substance for any other degree, and is not concurrently being submitted in candidature for any other degree.

This is to certify that the work here submitted was carried out by the candidate himself. Due acknowledgement has been made of any assistance received.

Signed 
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ABSTRACT

The waters of the Bostal Reservoir, Federal Republic of Germany, were investigated over a period of 18 months, at three stations and several variables were investigated: temperature, dissolved oxygen, ammonium, nitrate, nitrite, total organic nitrogen, total nitrogen, soluble reactive phosphorus, total dissolved phosphorus, total phosphorus, chlorophyll *a* and primary productivity.

Summer stratification took place between June and September, and total depletion of O_2 occurred during that time in the hypolimnion. In the anoxic hypolimnion ammonium and total nitrogen concentrations were high. Phosphorus was always present in the water column, and in 1984 was released from the sediments into the water. It did not occur in 1983.

During times of high solar intensity rates chl. *a*, and primary productivity rates were also high.

Due to its peculiar and unique situation the Bostal Reservoir could not be classified as far as the trophic status is concerned.

In order to improve the water quality of the reservoir the release of deep water is recommended, especially during the summer months.

ACKNOWLEDGEMENTS

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INTRODUCTION

Water is a major component of all ecosystems and of all living organisms. From the beginning of his appearance on earth, man entered the biogeoecological system of the hydrosphere utilizing increasing amounts of water. The population growth allied with great technological changes have raised the demand for several natural resources, and water is one of them. These changes, which have taken place during the last 150 years and in particular in developed countries have created a wide range of hydrological problems that are gradually leading to the deterioration of water.

Freshwater is a limited resource, and its quantity on the earth represents between 2 and 2.5 percent of salt-water (Golterman, 1975). Moreover, rainfall is not evenly distributed over land surfaces, nor is the human population distributed proportionally in relation to water availability.

Man decided to build dams to control the water flow where there was more, or less water than required. At present, the total artificially stored water capacity is greater than 4000 km^3, this represents a considerable part of the total circulating water in the atmosphere (Margalef, 1983).

Margalef (1975) considered a dammed river or an artificial lake as an environment intermediate between a river and a lake. Indeed, reservoirs normally show shorter ave-

rage retention time or a greater flushing rate than natural lakes. It is therefore, generally difficult or impossible to apply to reservoirs concepts that were originally developed for lakes. Lakes are normally very old (10^4-10^7 years) and to a certain extent stable systems, on the other hand, reservoirs are still very young (10^2 years), and because they are subject to human manipulation of outflow and water levels may never reach a stable state. Actually, a reservoir lacks the morphological characteristics of natural lakes, and the stratification and profundal deposits so typical of natural lakes may be markedly different (SCOPE, 1972).

The most accurate knowledge possible of aquatic ecology is indispensable for ecosystem research and environmental protection. In the case of reservoirs this is particularly true, because their formation is aimed primarily at the human population. Reservoirs have been created to store water for power generation, flood control, river outflow control, navigation, irrigation, urban water supply and waste disposal. Lately, in developed countries, due to the high demand of outdoor recreation on or near water, we have seen the construction of reservoirs for recreational activities as a whole (fishing, swimming, camping, sailing etc.).

One of the main problems arising from human activities for freshwater ecosystems is the nutritional enrichment of water bodies, that brings about their progressive deterio-

ration. Nutrient enrichment is likely to produce high production rates, while at the same time causing severe repercussions for the established communities, leading eventually to drastic community changes and diminishing diversity. Moreover, the increase in fertility in freshwater ecosystems stimulates algal blooms, heavy growth of macrophytes, deoxygenation, these leading to changes that are easily observed by the public as decreased clarity of the water, decreasing fishing sites, dying fish, and in some cases unpleasant odours. Because the effects are obvious to the public as well to the limnologist, the enrichment of the water body with nutrients has a major political impact.

There has been constant flux of information on the responses of lakes to increased nutrient inputs, especially in temperate regions, where considerable use has been made of models to quantitavely predict the responses of lakes to specific external stimuli by nature and man. In reservoirs, however, due to their unstable and particular conditions, such models can not be easily applied.

Much literature exists on the role of phosphorus and nitrogen as major factors responsible for the enrichment of water bodies, although the former appears to be more important among freshwater ecosystems (Nat. Acad. of Sci., 1969; Vollenweider, 1971; Likens, 1972; Wagner et al., 1976; Marvan et al., 1979; OECD, 1982).

This study was undertaken to assess the development of an 8 year old recreational purpose man-made lake. Pri-

mary production rates, chlorophyll *a* (chl. *a*) content,and the concentration of phosphorus and nitrogen in the water and in the sediments were also monitored throughout this investigation to subsidize the advice on measures aiming at the improvement of the water quality in the future. The study was carried out at the Bostal Reservoir, in Saarland, Federal Republic of Germany (FRG), from June 1983 to December 1984.

STUDY AREA

The Bostal Reservoir (Fig. 1) is an impoundment of two brooks: Bos and Dämelbach, which have a catchment area of 6.2 and 3.6 km^2, respectively. The reservoir lies at an altitude of ca. 380 m above mean sea level (MSL), just to the north of Saarland. The geographic position of the reservoir is shown in Fig. 2. Impoundment of water started in the winter 1975/76 and its final stage at 400 m above MSL was reached in April 1977 (Barth, 1978). Table I shows a few of the reservoir's morphometric measurements and characteristics at this stage.

Table I

Morphometric Measurements and Characteristics of the Bostal Reservoir*.

Water System	Rhine-Nahe
Catchment Area (km^2)	12.6
Surface Area (km^2)	1.185
Volume (m^3)	7.45×10^6
Maximal Depth (m)	16.0
Mean Depth (m)	6.3
Shoreline Length (km)	6.8
Development of Shoreline	1.76
Mean Depth/Maximal Depth	0.38
Development of Volume	1.18
Maximal Length (m)	1200.0
Relative Depth	1.38

*Expanded after Barth (1978) and Zaiss (1984).

Fig. 1 - Aerial view of the Bostal Reservoir.

Fig. 2 - Geographic position of the Bostal Reservoir on the hydrographic system of the FRG.

The water of the Bostal Reservoir is under direct control of the Saarland Water Management, which built the reservoir to provide recreational facilities for the northern region of Saarland. The poor wind protection of the surroundings and the dam on the leeside of sometimes prevailing winds may very likely induce a relatively unstable thermocline. Indeed, Zaiss (1981a) observed in 1979 that the thermocline was at a depth about 10 m, which meant that only 30 and 13 percent of the water body was stratified in relation to the surface area and total water volume respectively.

There is no arable land in the surroundings of the reservoir, and the human population living in the catchment area is also insignificant. However the nutrient rich surface layers of the formerly cultivated land were not removed prior to filling, thus serving as a nutrient pool. In March 1977 a wastewater pipeline which transported the effluents of two villages collapsed, releasing the wastes into the reservoir waters. Thereafter, the untreated sewage was continuously discharged into the water body until a provisional circular main was constructed later in that year. The nutrient-rich soil which had been covered by water, and the sewage load led to an accumulation of nutrients. As a result massive algal blooms were registered in 1978 and the reservoir was declared unsuitable for recreational purposes. In order to evaluate the future of the water an extensive limnological investigation was started

in 1979 (Kaltwasser & Zaiss, 1980; Zaiss, 1981a, 1981b, 1984).

Zaiss (1984) reported that the reservoir in 1979 had already recovered from the overfertilization caused by the 1977 sewage input, even though an anoxic hypolimnion and high production rates were found, as a result of the morphometric conditions (mean depth: 6.3 m), and a high phosphorus loading originating from the two brooks.

The Bostal Reservoir was classified as eutrophic by Kaltwasser & Zaiss (1980), using models proposed by Vollenweider (1971) and Schröder & Schröder (1978).

This study was undertaken to provide limnological information in order to allow recommendation for the future of the water body. The study was carried out at three stations in the Bostal Reservoir (Fig. 3), Saarland, FRG.

Fig. 3 - Simplified bathymetric map (after Zaiss, 1984) and sampling sites.

MATERIAL AND METHODS

Samples were collected at 3 stations as indicated in Fig. 3. The investigation was carried out in the Bostal Reservoir between June 1983 and December 1984. During the time the water was iced over (January-March 1984) the work was suspended. Water samples were collected fortnightly during the summer, and at least monthly in other periods. During the time of the investigation 25 visits were made to the reservoir.

Lakewater samples were taken with 3.0 dm^3 water bottle (Hydrobios, Kiel, FRG). The sampler consists of an acrylic tube 1.2 m long with closure devices at each end that can be triggered by a messenger. After the retrieval of the sampler to the boat, the water to be sampled was released through a piece of surgical rubber direct into sampling bottles.

At each time the following parameters were determined: temperature, dissolved oxygen, soluble reactive phosphorus, total dissolved phosphorus, total phosphorus, ammonium, nitrite, nitrate, dissolved organic nitrogen, total nitrogen, chl. *a* and primary production rates (incorporated and released carbon).

At stations I and III (4.6 m deep) samples were taken at each meter. For the station II, however, they were collected at the following depths: 0, 1, 2, 3, 5, 7, 9, 11, 13, and 16 m. At all stations sediments have also been collected and total nitrogen and total phosphorus in the

interstitial water were estimated.

Protection of samples from heat and from direct exposure to sunlight was always reinforced. Special precautions were taken to protect the chl. a and primary production samples from exposure to light.

Samples were either frozen with dry-ice or stored in ice-boxes and covered with small pieces of ice.

Sediment samples were collected with a dredge (Hydro-Bios, Kiel, FRG) transferred to glass bottles sealed with rubber rings and glass cover, and transported in ice-boxes to the laboratory. A portion of the sediment was centrifugated at ca. 10000 rpm for approximately 10 min to remove interstitial water. Following centrifugation the interstitial water was analysed for total N and total P after a persulfate oxidation, in a basic and acid media respectively (Koroleff, 1976b,1976c).

After the end of each sampling period the sample bottles were always rinsed with deionized water and filled to the top with a 1 N HCl solution and kept at least 24 hours, where they were emptied and rinsed copiously with deionized water and dried.

The methods utilized in this work are summarized briefly here.

Temperature and Oxygen

Temperaure and oxygen profiles were measured with a Yellow Springs Instrument Co. (Ohio, USA) Model 518 combi-

ned temperature-oxygen probe. The oxygen content in some samples were also determined using the Winkler technique described in Golterman et al. (1978) in order to confirm the results given by the oxygen-meter.

Chlorophyll a

Chl. a contents were estimated employing the method recommended by Nusch (1980). Samples were brought to the laboratory and immediately analysed. Known volumes of lakewater were filtered by means of gentle suction through a fibre-glass filter (Schleicher & Schüll, Ø 50 mm, Nr. 11). A few drops of a saturated $MgCO_3$ suspension were added just after collection to prevent the degradation of the chlorophyll. After the sample had passed through the filter, the filter was ground with a teflon pestle attached to a small rotary electric motor with 10 cm^3 of 90 percent (v/v) ethanol at 78 °C until it was thoroughly macerated and placed in a plastic vial. The vials were left to stand for 24 hours in the refrigerator for overnight extraction. Following pigment extraction, samples were either filtered through a small fibre-glass filter or centrifugated, in order to separate the small pieces of the macerated filter from the filtrate. The absorbance of samples was read at 665 and 750 nm before and after acidification with 2 drops of a 1N HCl using a Perkin-Elmer spectrophotometer (Model 550S). 90 percent (v/v) ethanol was used as a blank and chl. a was determined utilizing the equation suggested by Nusch (1980).

Nitrogen

Water samples were analysed directly for the nitrogen inorganic fraction (NO_3^-, NO_2^- and NH_4^+) and total nitrogen. By subtracting the concentration of inorganic nitrogen from the total nitrogen, the amount of organically bound nitrogen was obtained. Interstitial water obtained from sediment samples were analysed exclusively for total nitrogen.

In order to perform the analysis of different nitrogen compounds in water and sediments the following methods were employed:

Compound	Method	Limitation
Ammonium	Koroleff, 1976a	0.05-90.0 µg at NH_4^+-N.dm^{-3}
Nitrate	Wood et al., 1967	0.05-90.0 µg at NO_3^--N.dm^{-3}
Nitrite	Shinn, 1941; Grasshoff, 1976	0.005-120.0 µg at NO_2^--N.dm^{-3}
Total Nitrogen	Koroleff, 1976c	0.005-120.0 µg at N.dm^{-3}

Phosphorus

For the determination of phosphorus compounds in the water the method employed is based on the reaction of the phosphate ions with an acidified molybdate reagent to yield a phosphomolybdate complex, which is then reduced to a highly coloured blue compound. The method follows essentially the procedure of Murphy & Riley (1962), slightly

modified by Koroleff (1976b).

Samples were collected in PVC bottles of 250 ml directly from the water-sampler. From this sample two sub-samples were taken at the time of the analysis. The first sub-sample was used to determine the dissolved inorganic phosphate fraction. The second sub-sample was autoclavated for half an hour in a closed bottle with peroxodisulfate, and later analysed for total phosphorus. In order to estimate the total dissolved phosphorus concentrations samples were filtered still in the field through phosphate-free filters (0.45 µm pore size, Ø 47 or 25 mm, Sartorius, Göttingen, FRG), and the same procedure such as used to estimate total phosphorus was undertaken to determine the total dissolved phosphorus fraction. This fraction includes all the dissolved forms of the element.

Steinberg & Schrimpf (1980) recommended that the blue staining complex resulting from phosphorus analysis by the molybdate method (Murphy & Riley, 1962) should be presented as soluble reactive phosphorus (SRP) instead of the normal "orthophosphate", here dissolved inorganic phosphate, as only a small part of the stained phosphorus is really orthophosphate; other easily hydrolizable phosphorus compounds are likely to take part in this unidentified fraction.

Primary Productivity

For the measurement of phytoplankton primary production rates the ^{14}C-method (Steeman-Nielsen, 1952) was uti-

lized. Lakewater was collected at different depths. Water sub-samples were placed into sterile Winkler bottles, plus a similar formalin killed sample. One cm^3 aliquot was removed from all the bottles and 1.0 cm^3 of a $NaH^{14}CO_3$ solution containing 1 µCi (New England Nuclear, Dreieich, FRG) inocculated into the bottles. The samples were then lowered to the depth they were collected and incubated for approximately four to six hours between 10 00 and 17 00 hours at the three stations. Such interval seems to be optimal for the measurement of ^{14}C assimilated, and it is also sufficiently brief to minimize errors incurred from longer exposure as a result of bacterial growth on the wall of the bottles, respiratory cycling of CO_2, nutrient depletion, photochemical destruction of chl. a and so on (Vollenweider, 1965; Gieskes et al., 1979). At stations I and III samples were incubated at 1.0, 3.0 and 4.5 m, at station II at 1.0, 3.0, 5.0 and 9.0 m. Incubations were terminated by addition of neutral formalin and returned to the laboratory for processing. The sample was then filtered through a membrane filter (0.45 µm pore size, Ø 47 mm, Sartorius, Göttingen, FRG) in order to estimate the ^{14}C amount incorporated by the organisms. To avoid possible cell disruption a vacuum pressure < 200 mm Hg was always exerted. Each filter was washed with 50 cm^3 of freshly deionized water, dried and exposed to fumes of concentrated HCl for 10 min as suggested by Wetzel (1965) to remove residual inorganic ^{14}C and carbonates that have precipitated as a result of photosynthetic activity. The

filter was placed individually in plastic vials. Into each vial 20 cm^3 of a combination of Unisolve I (Zinsser Analytic, Frankfurt, FRG) and methanol (850 + 150 v/v respectively) was added. The vials were shaked in the upside-down position for ca. 20 min in order to avoid settling of the dissolved filter on the bottom of the vial, and then causing further quenching. Efficiency of counting was determined by the channels ratio technique using ^{14}C-hexadecane (Amershan International, Amershan, U.K.). To determine the actual amount of carbon released by phytoplankton the following procedure was employed. 10 cm^3 aliquot of the filtered sample was acidified and air-bubled for 20 min to remove remains of inorganic ^{14}C. One cm^3 aliquot of this was placed into a scintillation vial with 20 ml of the Unisolve-Cocktail and the activity measured.

Counts/minute (CPM) were obtained from a Beckman 7500 Liquid Scintillation Counter. CPM were adjusted for volume differences, corrected for DPM (desintegrations per minute). Total production rates were determined from the formulae of Strickland & Parsons (1968), with total production equalling particulate ^{14}C fixed plus dissolved organic ^{14}(DOC) released. Percentages of released ^{14}carbon were calculated as

$$\frac{DOC \times {}^{14}C}{\text{Tot. Produc.}\,{}^{14}C} \times 100$$

All the samples were corrected for background counts. The determination of total CO_2 was carried out according to

the method described by Golterman et al. (1978).

In an attempt to circumvent spatial and temporal variations chl. a and primary production results were integrated using the following method: for each depth interval a mean was estimated using the values of the three sampled stations. This mean was then multiplied by the actual volume of water in that layer. The results of each of these strata are summed and divided by the actual volume of the reservoir.

Primary production data are shown as hourly rate (mg $C.m^{-3}.h^{-1}$), calculated by dividing the total uptake plus the ^{14}C-extracellular fraction by the incubation time in hours, and integrating the results as already described.

Since the incubation time has been shown to affect uptake per unit time (Eppley & Sharp, 1975), the values presented here cannot be extrapolated to daily uptake rates or be compared to data with different times of incubation.

RESULTS

The water transparency (Secchi disc depth) was determined with a common Secchi disc. The maximum transparency measured was found in December for both years, while in August the lowest values were recorded (0.95-1.20 m). At other times, values for transparency varied from 1.30 to 3.80 m. There has been no visible variation between Secchi disc transparency measurements at the stations sampled during the period studied. The Secchi disc depth fluctuation for the period June 1983-December 1984 is shown in Fig. 14a, 14b, 14c and 14d , together with chl. a values.

In the Bostal Reservoir the temperature of the water ranged from 4.5 to 12.2 and 4.5 to 24.0 °C in the hypolimnion and epilimnion respectively. The lowest temperature values were measured in winter, during the homogenous period. During the summer stratification, the highest value for temperature measured was 24.0 °C in July 1983. The temperature profiles at the stations II and I and III for the period June 1983-December 1984 are shown in Fig. 4a, 4b, 4c and 4d.

All data show that the Bostal Reservoir surface waters (top 5.0 m) were generally well supplied with dissolved oxygen; here the minimal and maximal average concentrations of oxygen varied between 8.64 and 11.45 mg $O_2.dm^{-3}$. The hypolimnion was completely depleted from O_2 during July-August in 1983 and from July until early September in 1984 (Fig. 5a, 5b, 5c and 5d).

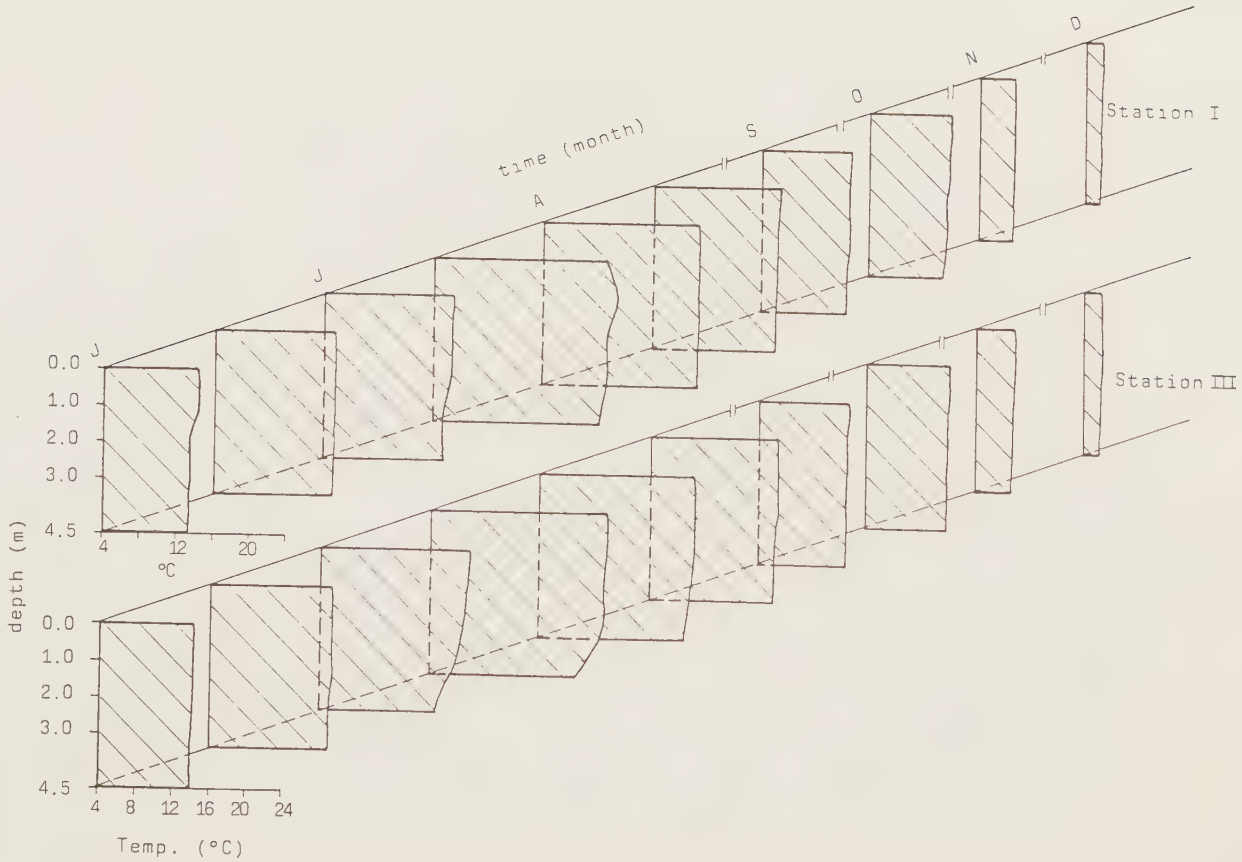

Fig. 4a - Seasonal variation of temperature at Station I and Station III in the Bostal Reservoir for the year 1983.

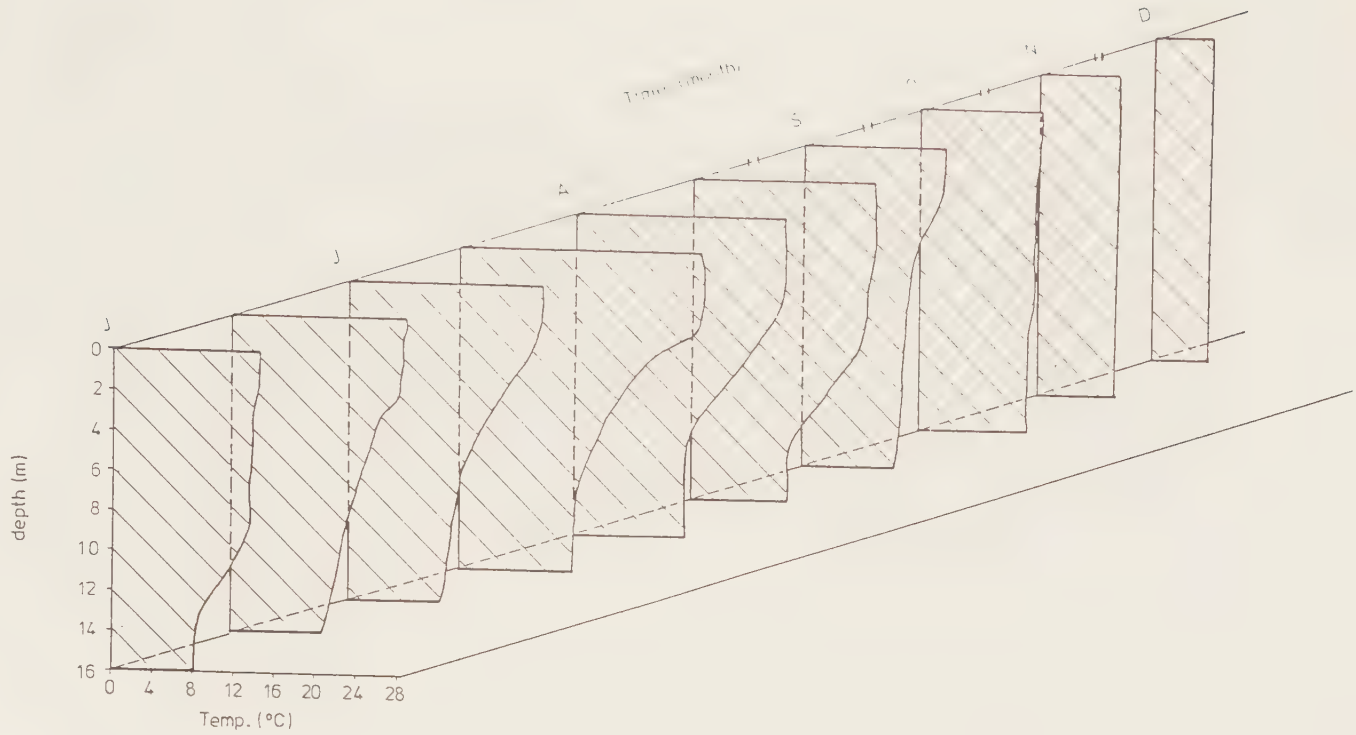

Fig. 4b - Seasonal variation of temperature at Station II in the Bostal Reservoir for the year 1983.

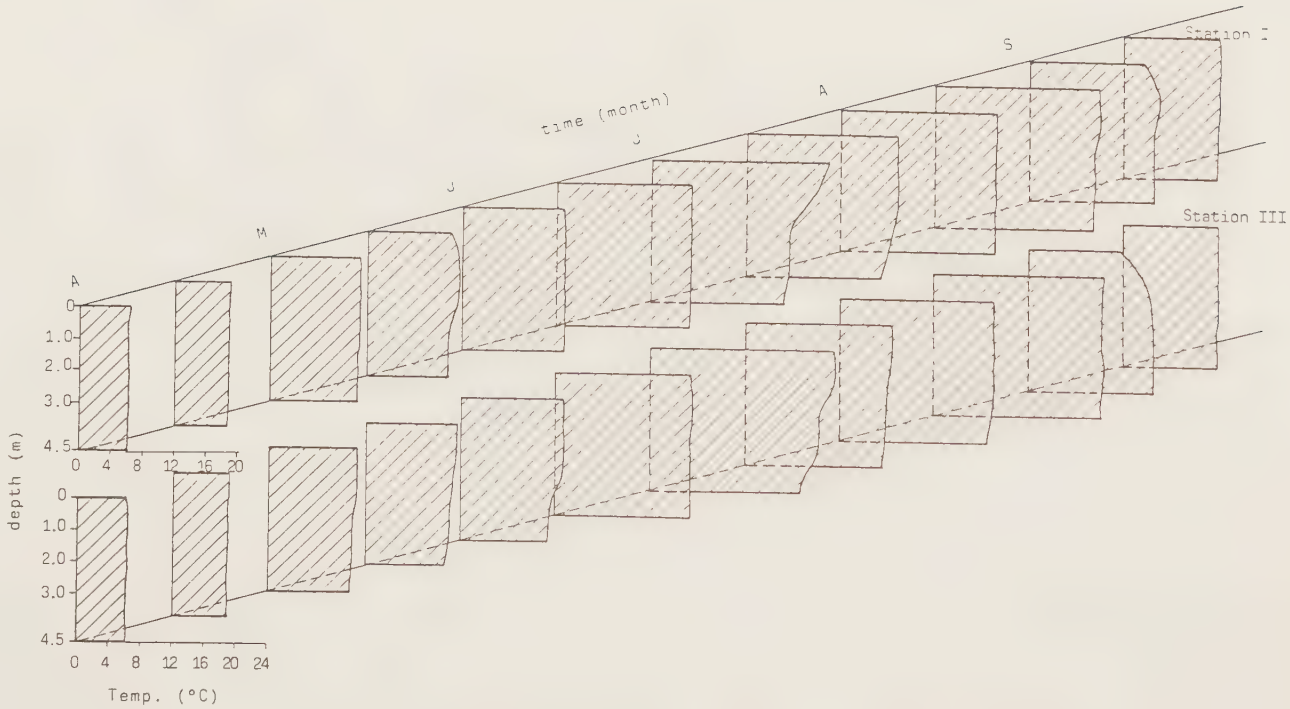

Fig. 4c - Seasonal variation of temperature at Station I and Station III in the Bostal Reservoir for the year 1984.

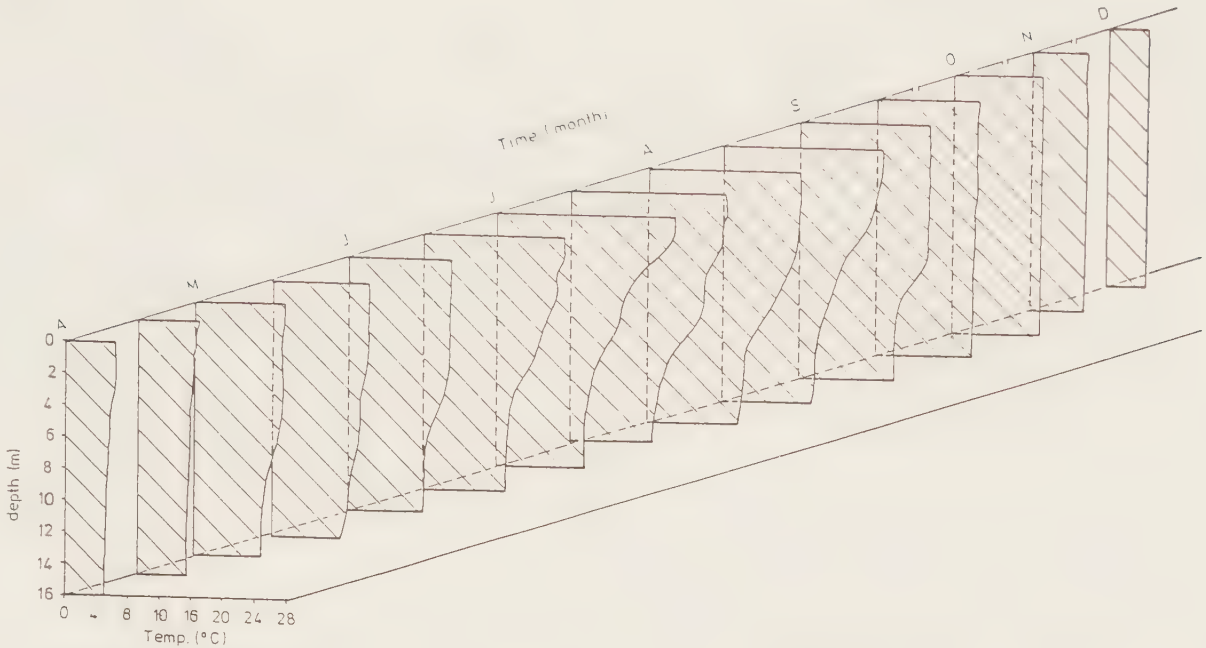

Fig. 4d - Seasonal variation of temperature at Station II in the Bostal Reservoir for the year 1984.

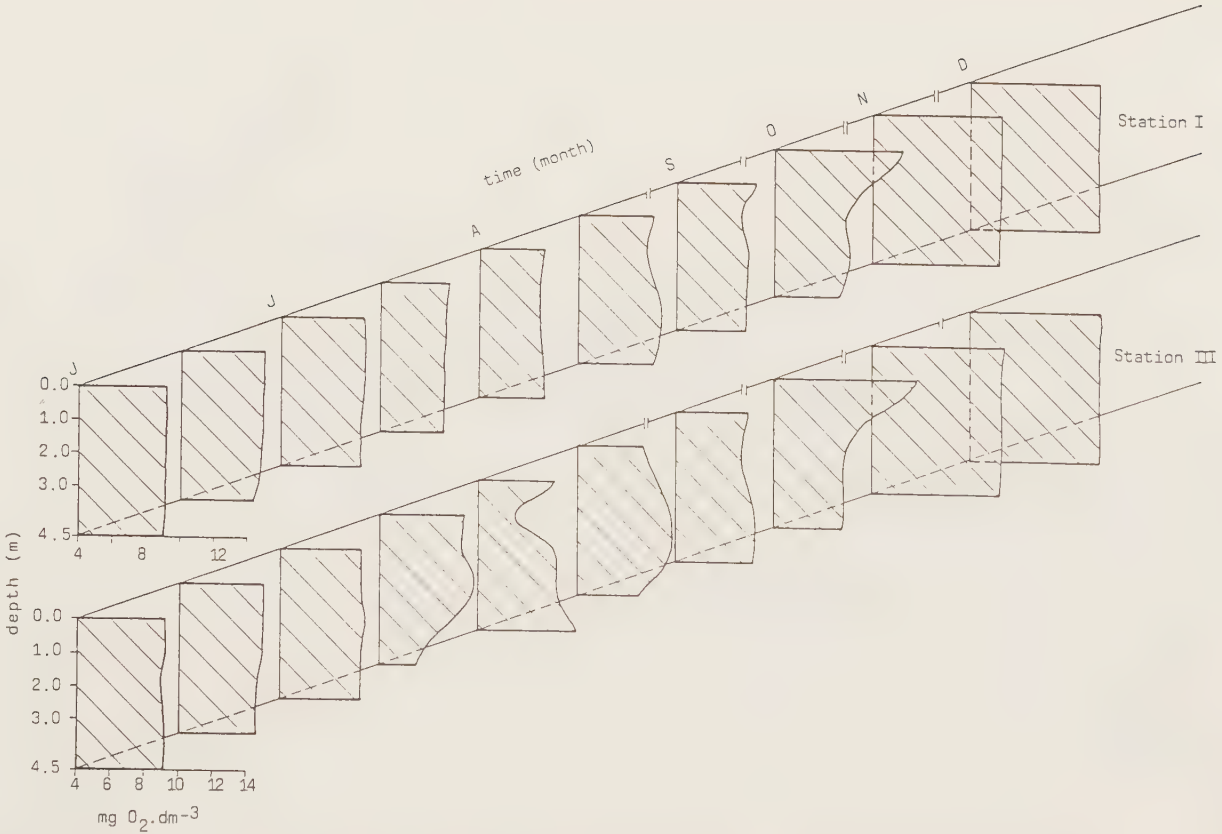

Fig. 5a - Seasonal variation of dissolved oxygen at Station I and Station III in the Bostal Reservoir for the year 1983.

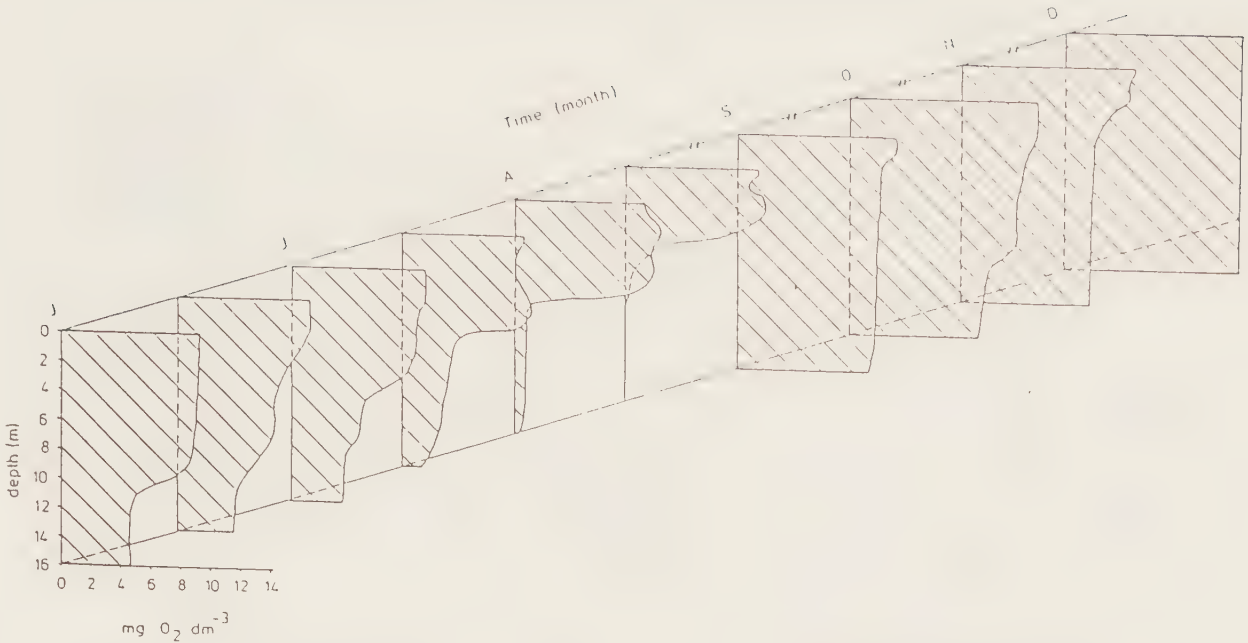

Fig. 5b - Seasonal variation of dissolved oxygen at Station II in the Bostal Reservoir for the year 1983.

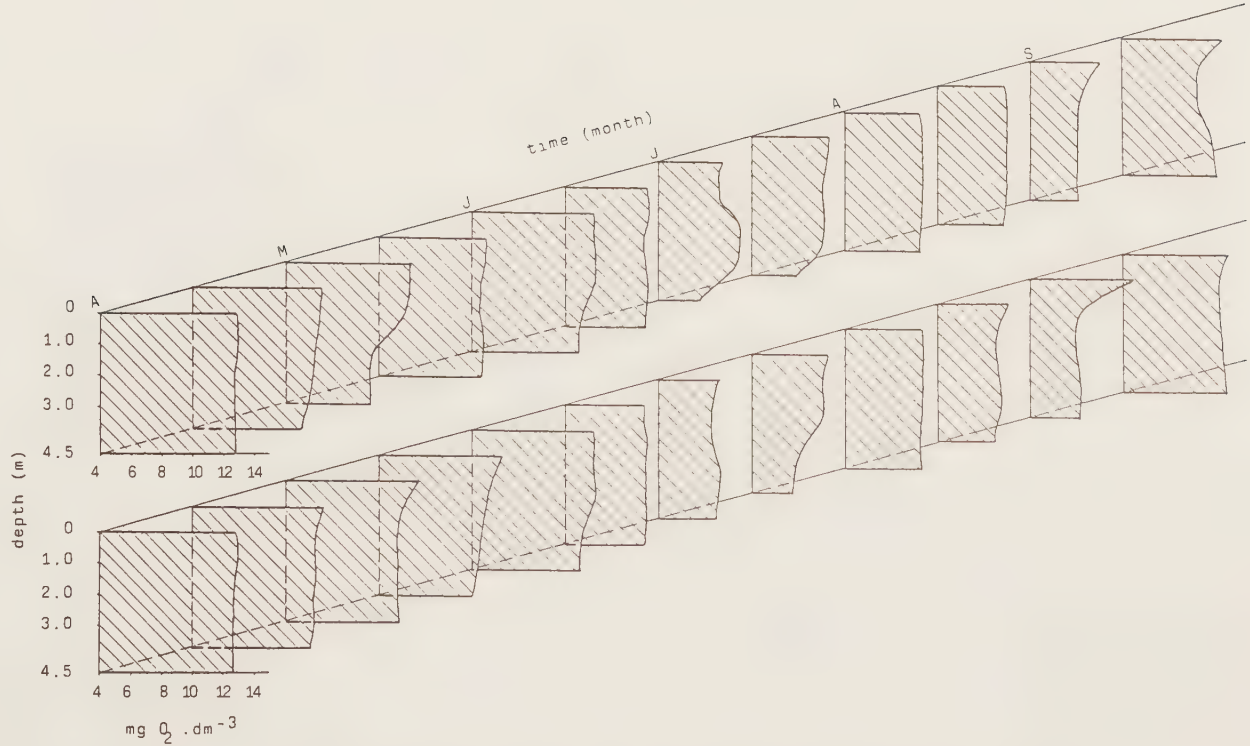

Fig. 5c - Seasonal variation of dissolved oxygen at Station I and Station III in the Bostal Reservoir for the year 1984.

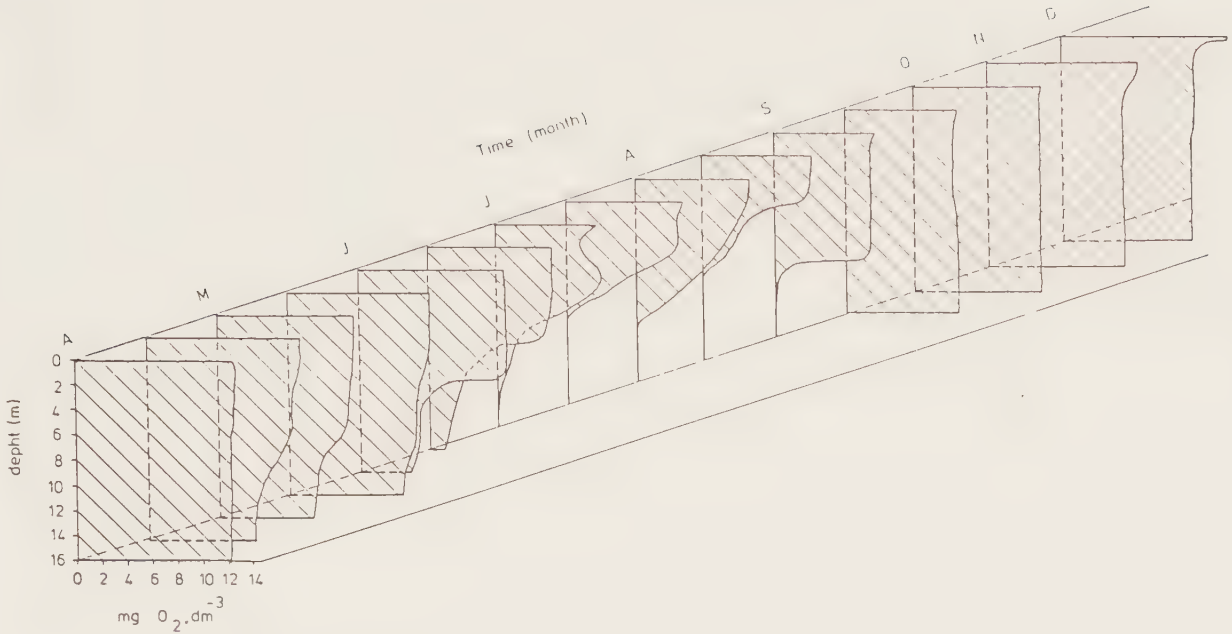

Fig. 5d - Seasonal variation of dissolved oxygen at Station III in the Bostal Reservoir for the year 1984.

By the end of the winter with total circulation, the O_2 levels were relatively high (ca. 12.0 mg $O_2.dm^{-3}$) on the water body. As soon as the first algal bloom disappeared the oxygen in the bottom waters began to decrease. As thermal stratification established and the temperature gradient increased, oxygen concentrations decreased considerably in the hypolimnion. A sharp oxycline developed at the thermocline and the dissolved oxygen contentdropped drastically to low and zero values at the deepest sampling site. Towards the end of the stratification period as a result of the sinking of the thermocline and of its increased weakness the oxygen content of the deep water increased. The rate at which the dissolved oxygen locked in the hypolimnion is consumed also increased as one progresses towards the dam. During the summer, as a consequence of high production rates oxygen levels in the euphotic zone remained high (between 7.9 and 10.0 mg $O_2.dm^{-3}$.

Rarely has it been observed that the dissolved oxygen concentration in the epilimnion had decreased below 80 percent of the saturation value. In fact, most of the time the surface waters were nearly saturated or even oversaturated with oxygen. Maximum dissolved oxygen concentrations saturations were observed during the summer. The dissolved oxygen contents of the surface waters ranged mostly between 90 and 110 percent saturation.

The ammonium concentration of the water in the study area varied between 0.60 and 39.51 µg at NH_4^+-N.dm^{-3}. It

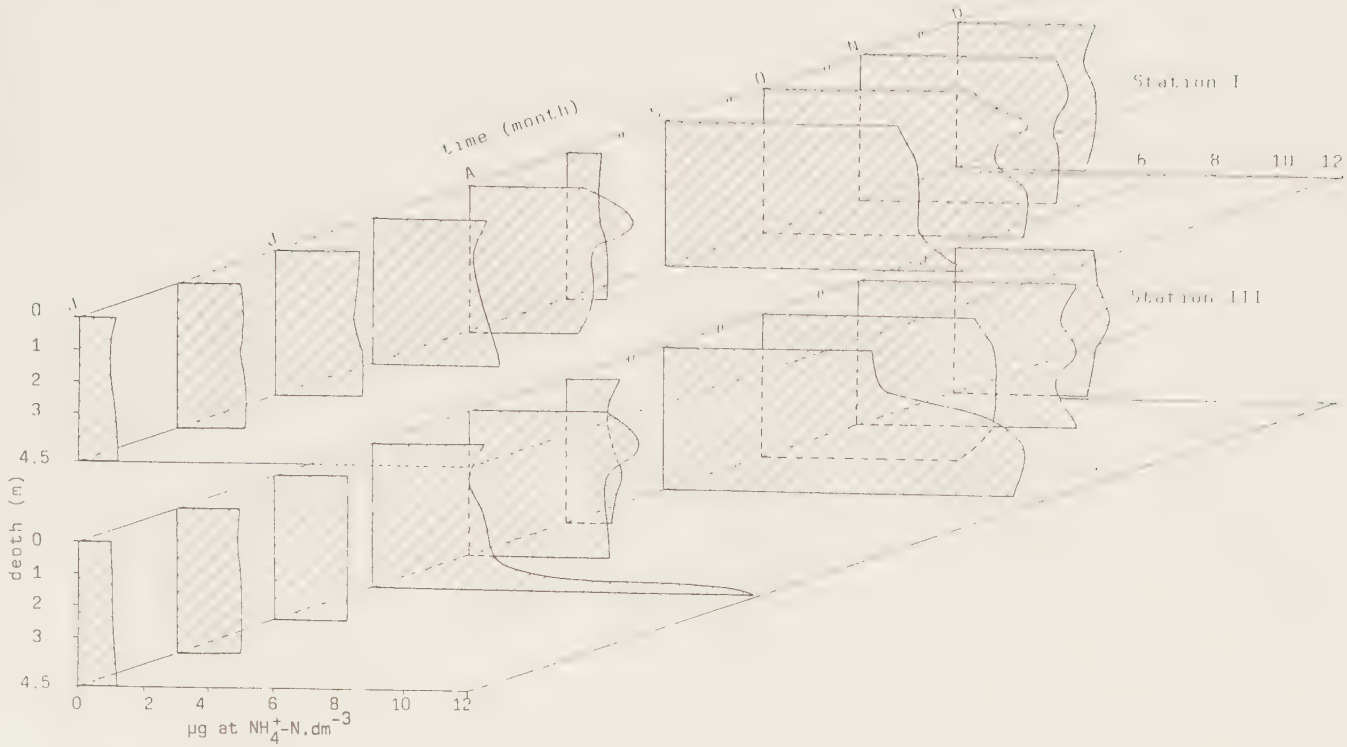

Fig. 6a - Seasonal variation of ammonium at Station I and Station III in the Bostal Reservoir for the year 1983.

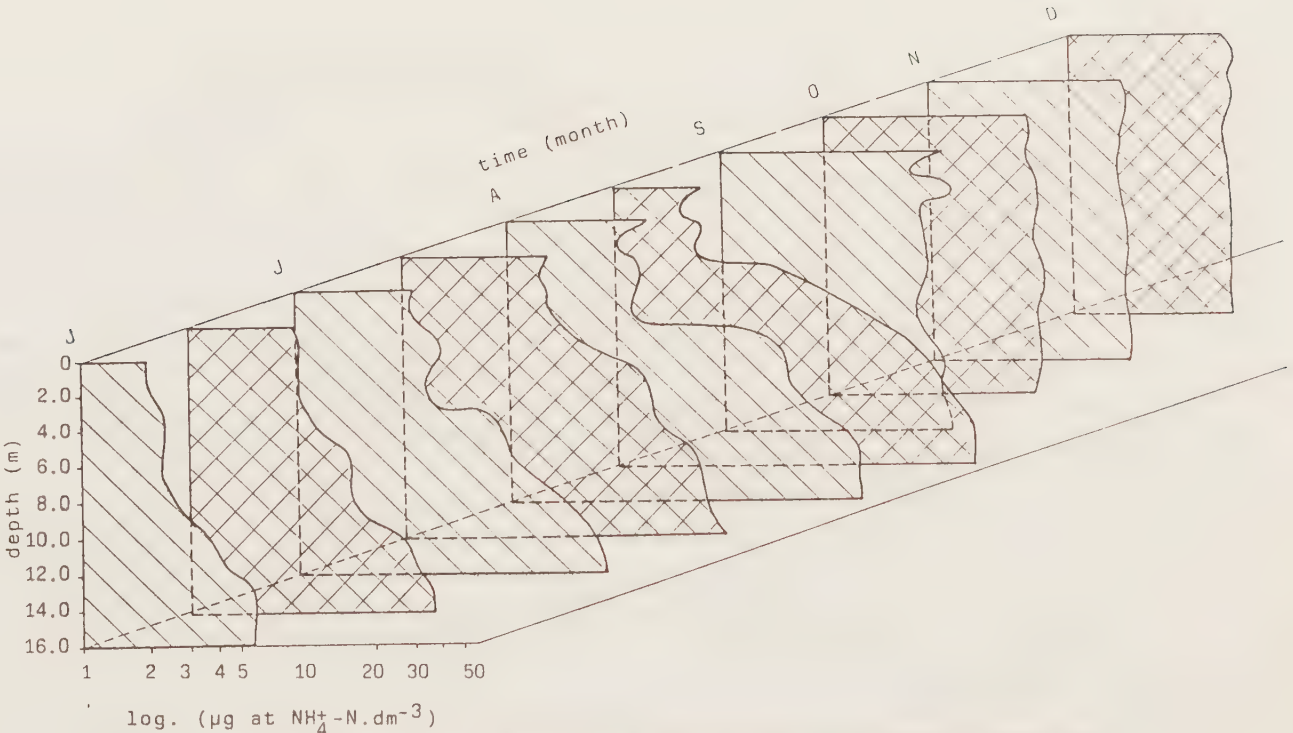

Fig. 6b - Seasonal variation of ammonium at Station II in the Bostal Reservoir for the year 1983.

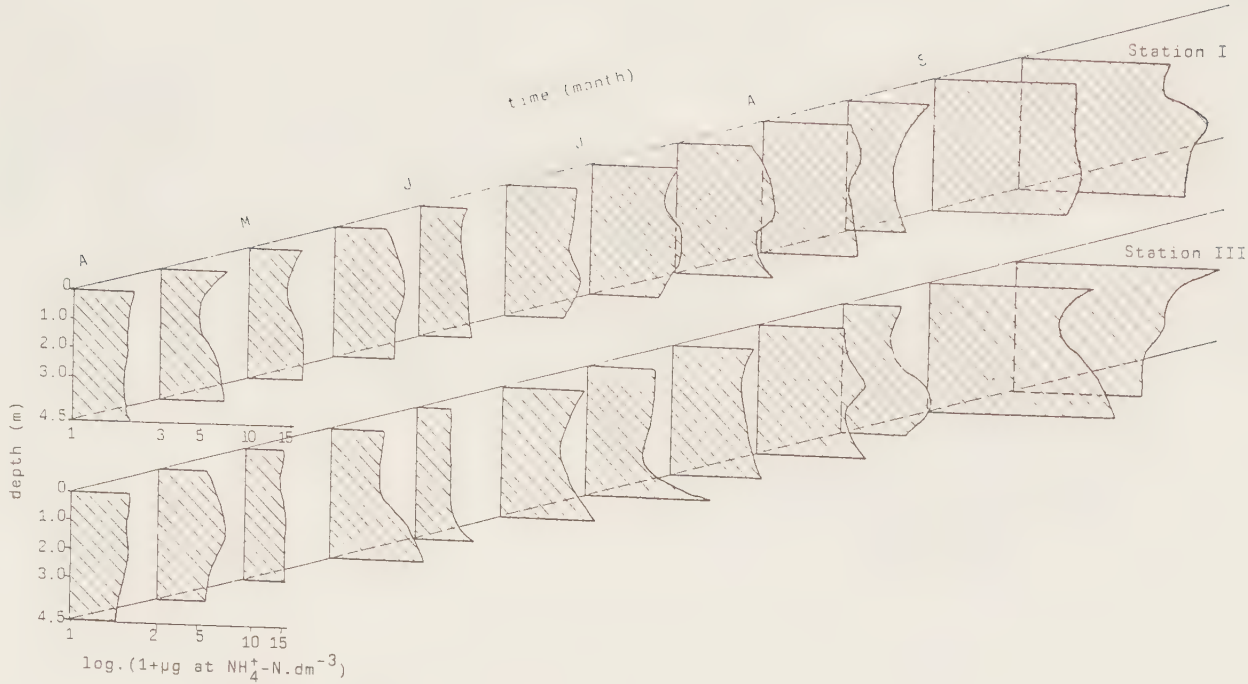

Fig. 6c - Seasonal variation of ammonium at Station I and Station III in the Bostal Reservoir for the year 1984.

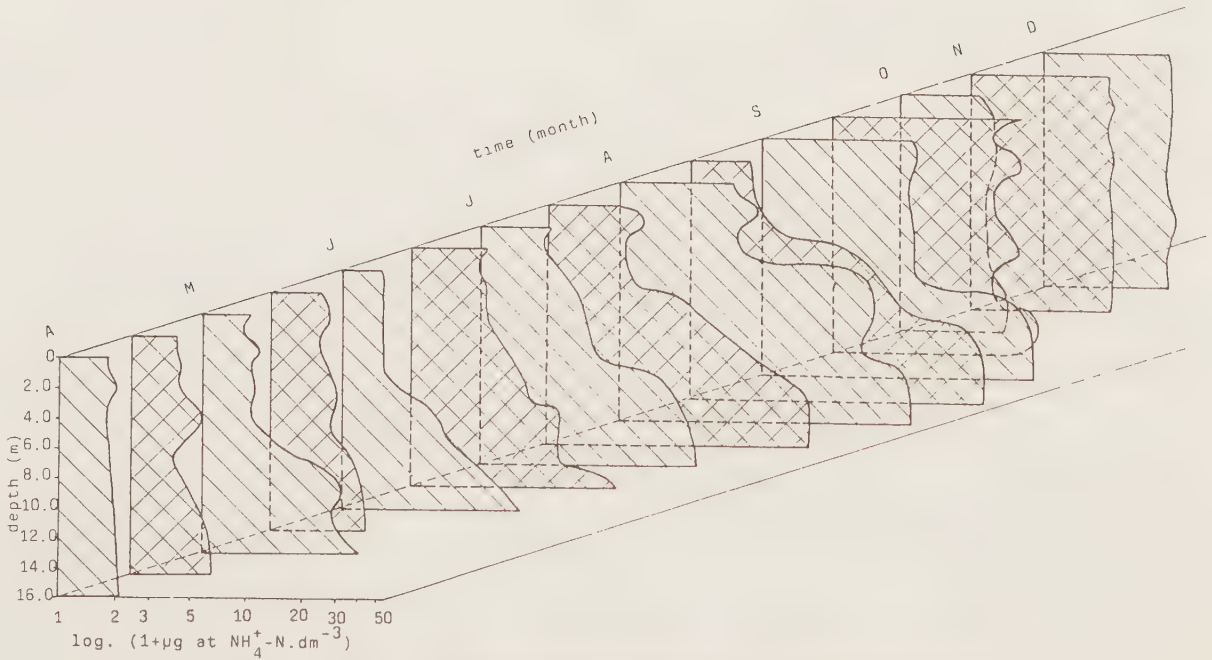

Fig. 6d - Seasonal variation of ammonium at Station II in the Bostal Reservoir for the year 1984.

underwent relatively large fluctuation throughout the seasons, especially at the station II. Taken as a whole, however, during summer months higher values were registered than in the spring and winter (See Fig. 6a, 6b, 6c and 6d).

At the time of full circulation in April 1984 the ammonium concentration in the water did not show any horizontally or vertically variation, values in this month varied between 0.85 and 1.29 µg at NH_4^+-N.dm^{-3}. In May with raising temperatures and decreasing dissolved oxygen in the water, ammonium contents begun to increase steadly, especially at higher depths. Ammonium concentrations raised continuously in the anaerobic hypolimnion throughout the summer months, until the end of the summer stratification, when the highest values were found in the deep waters for both years. Just after the end of the summer stratification the ammonium concentrations became almost uniform in the water column and were relatively high.Thereafter, ammonium concentrations in the water begun to sink towards the winter period. At the stations I and III this pattern was quite different. At these stations O_2 content did not reach very low values, therefore an anaerobic stratum had not been developed, that hindered the formation of ammonium.

The nitrite concentrations were relatively low in the entire area of investigation throughou the work. They varied between 0.10 and 2.77 µg at NO_2^--N.dm^{-3}. The values at the station II, especially at higher depths during the

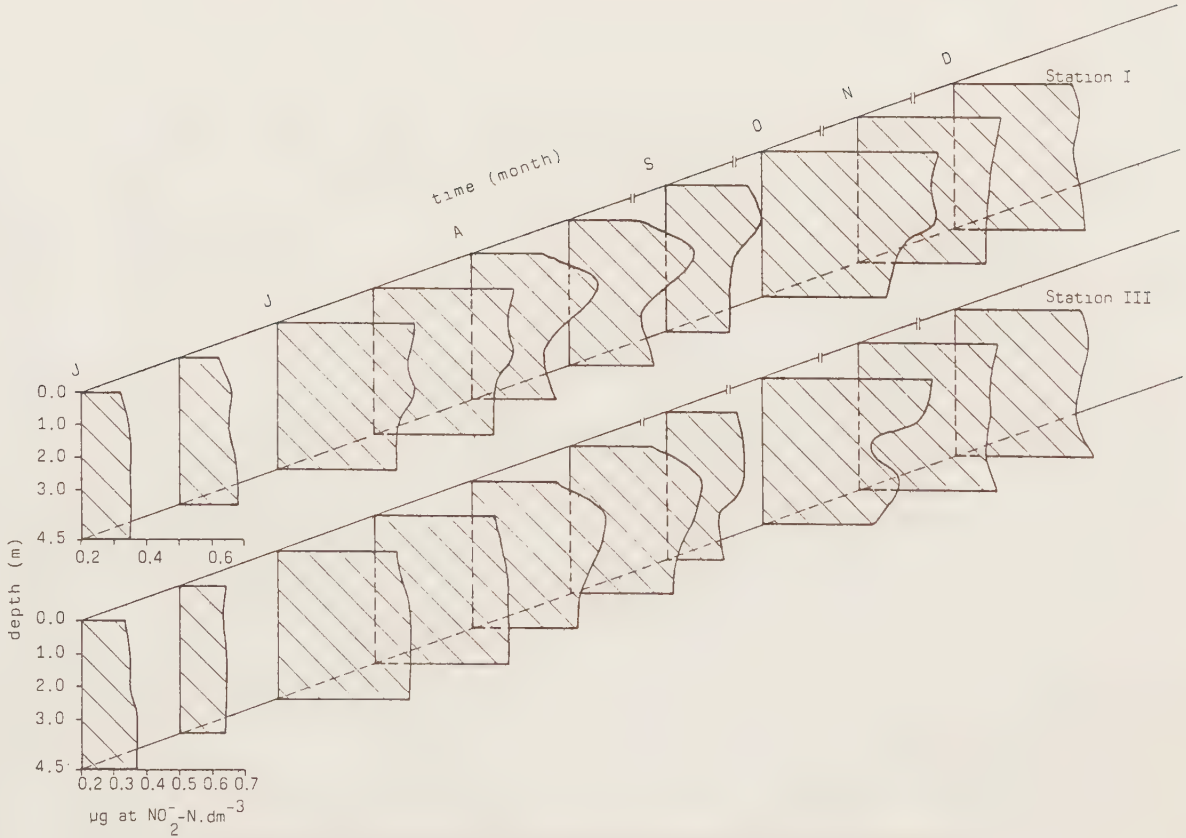

Fig. 7a - Seasonal variation of nitrite at Station I and Station III in the Bostal Reservoir for the year 1983.

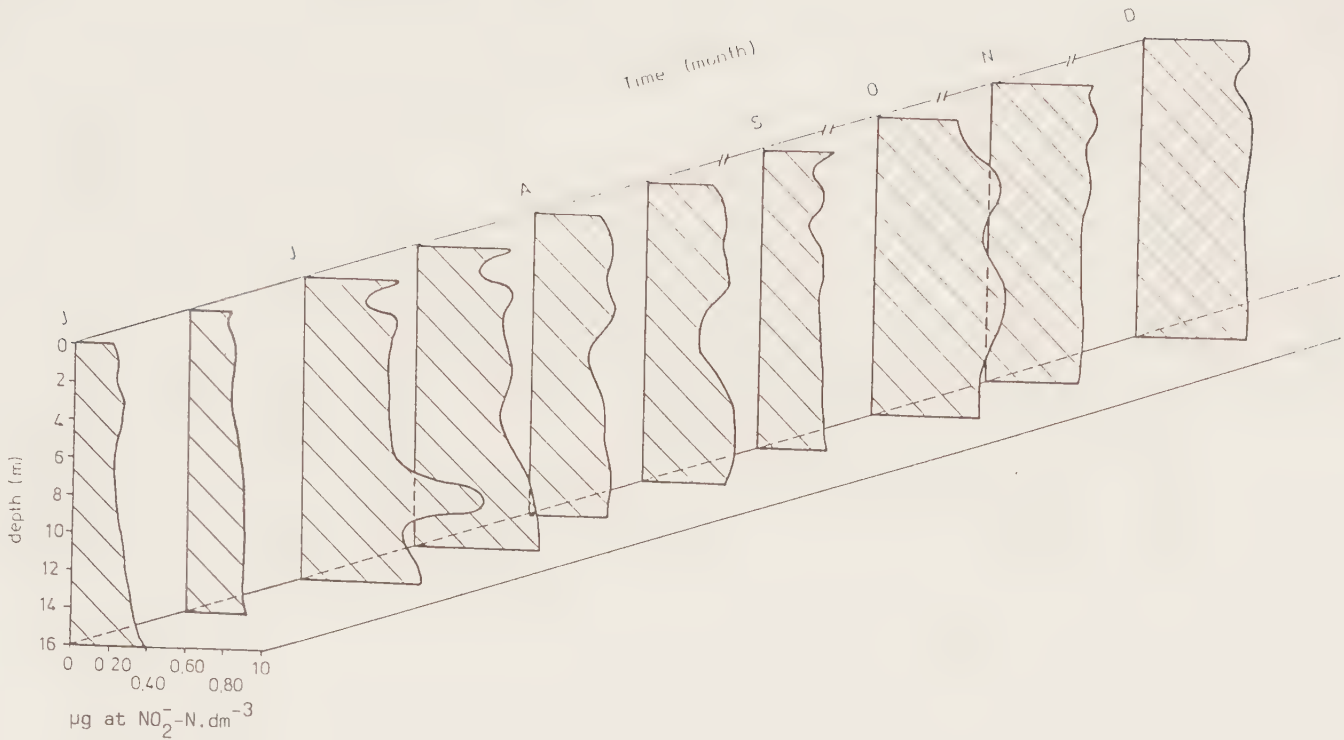

Fig. 7b - Seasonal variation of nitrite at Station II in the Bostal Reservoir for the year 1983.

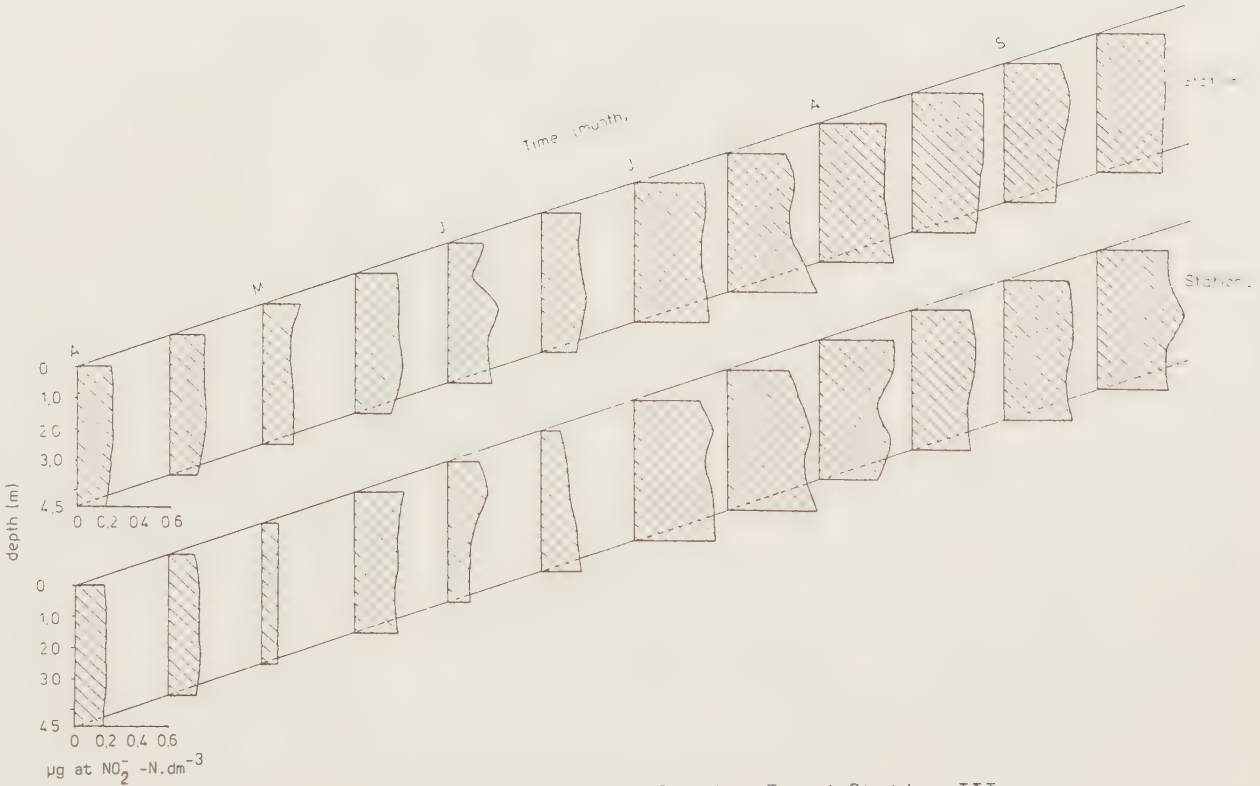

Fig. 7c - Seasonal variation of nitrite at Station I and Station III in the Bostal Reservoir for the year 1984.

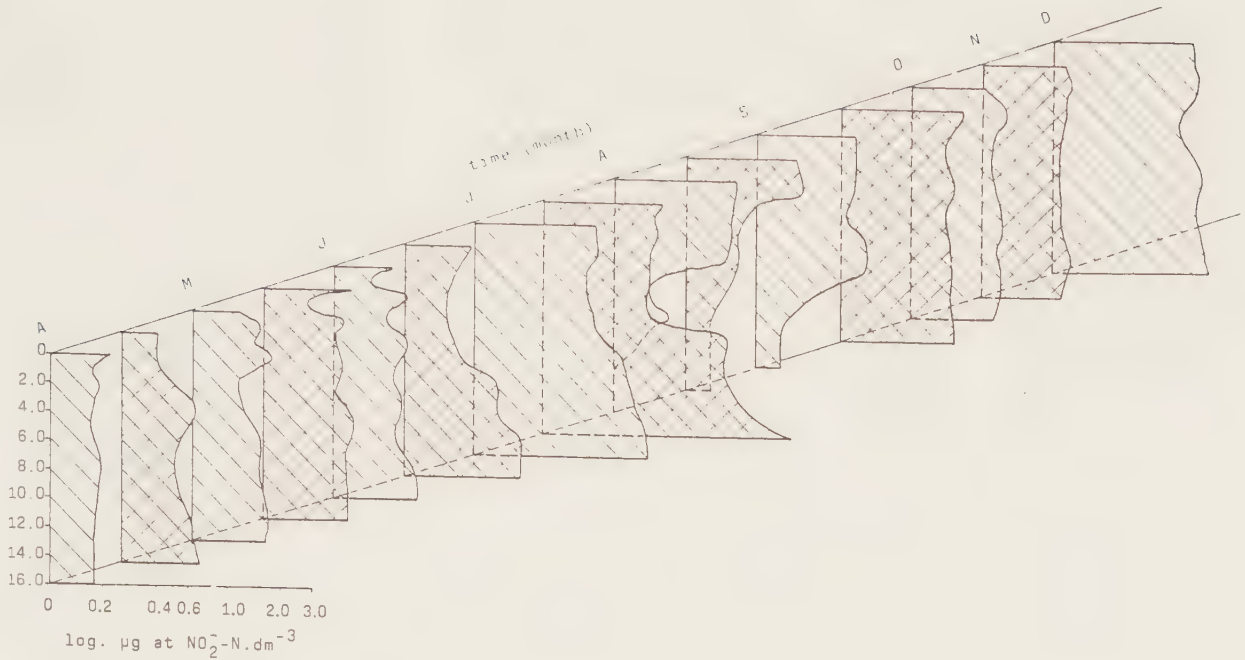

Fig. 7d - Seasonal variation of nitrite at Station II in the Bostal Reservoir for the year 1984.

summer were clearly greater than these at the other two stations. The nitrite content of samples showed a distinct seasonal cycle with relatively low values in winter and spring and higher summer values (See Fig. 7a, 7b, 7c and 7d). In the summer, in spite of very sensitive method of analysis, at a certain depths only small amounts of nitrite could be measured.

The nitrate content showed a pronounced yearly cycle with quite high winter values and very low summer values at all stations sampled. The fluctuation of nitrate in the Bostal Reservoir waters are represented in Fig. 8a, 8b, 8c and 8d. The nitrate concentrations varied over a wide range between 0.56 and 69.12 µg at NO_3^--N.dm^{-3}. The nitrate content of water samples also varied horizontally in the water column throughout the year. The values for nitrate at the stations I and III have shown no difference at all. At thedeepest station (II), however, a remarkably nitrate fluctuation occurred at different depths right through the year.

By the end of the year with total circulating water NO_3^- contents were very high at all studied stations. As the water temperature raised towards the summer, nitrate levels begun to decrease horizontally and vertically. As the thermal stratification became more pronounced and as the temperature values increased more rapidly nitrate concentrations in the water diminished. Just after the end of the stratification period, nitrate levels augmented sharply, reaching considerably high values within a few

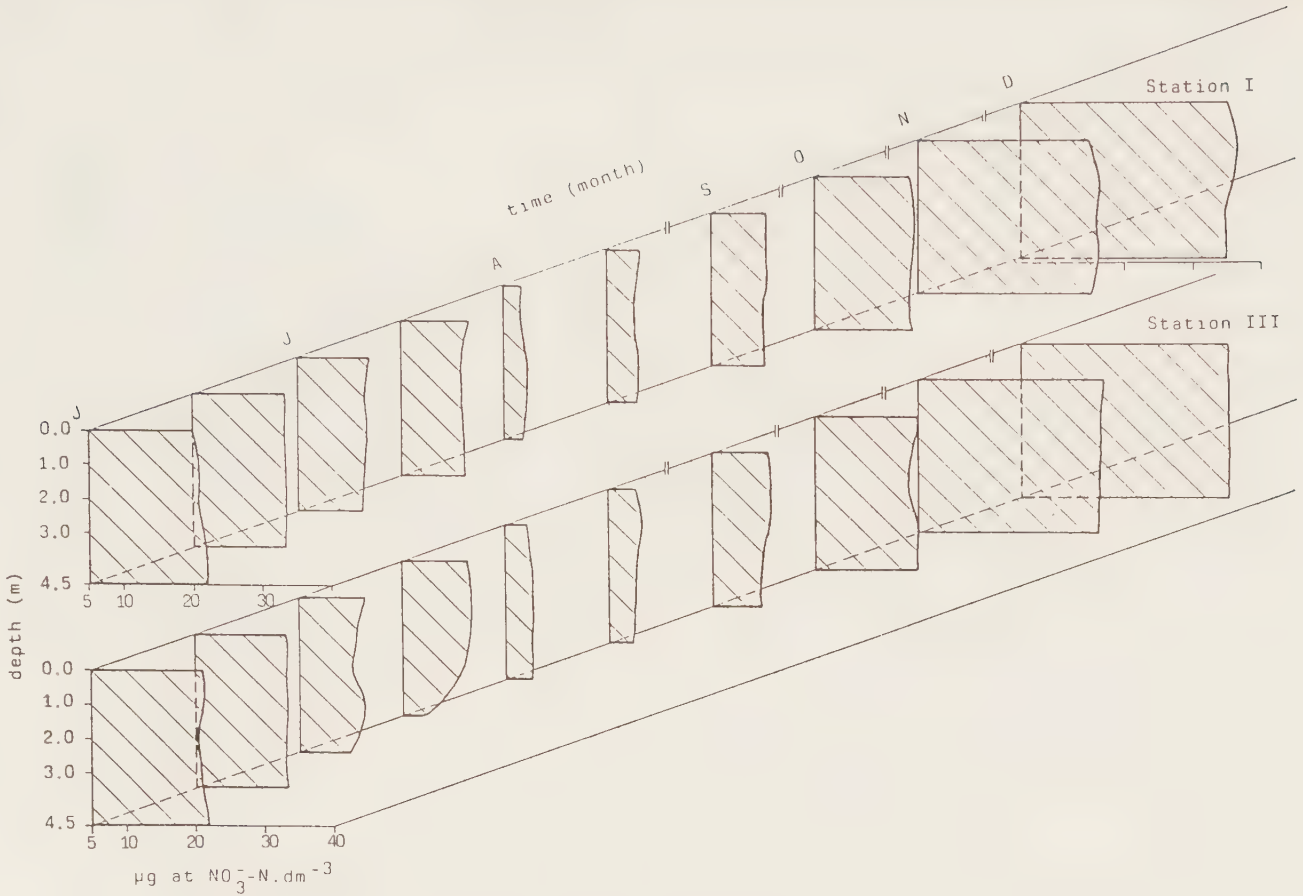

Fig. 8a - Seasonal variation of nitrate at Station I and Station III in the Bostal Reservoir for the year 1984.

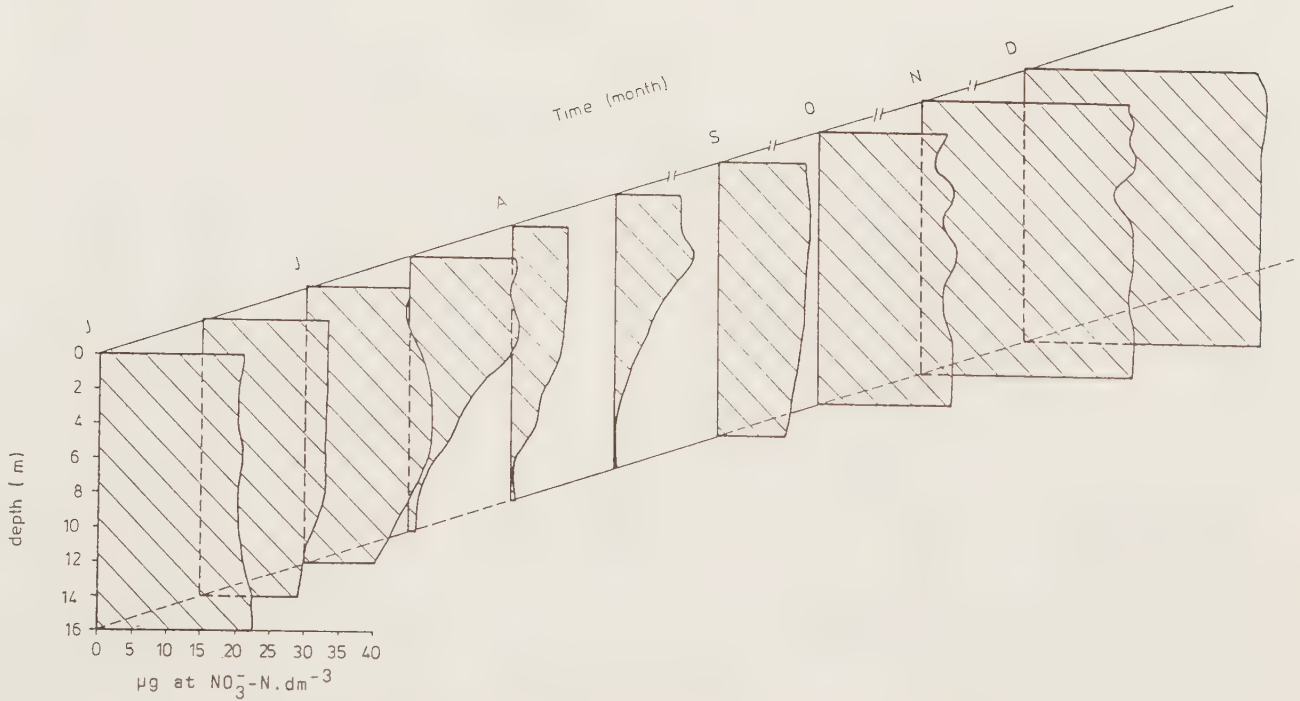

Fig. 8b - Seasonal variation of nitrate at Station II in the Bostal Reservoir for the year 1983.

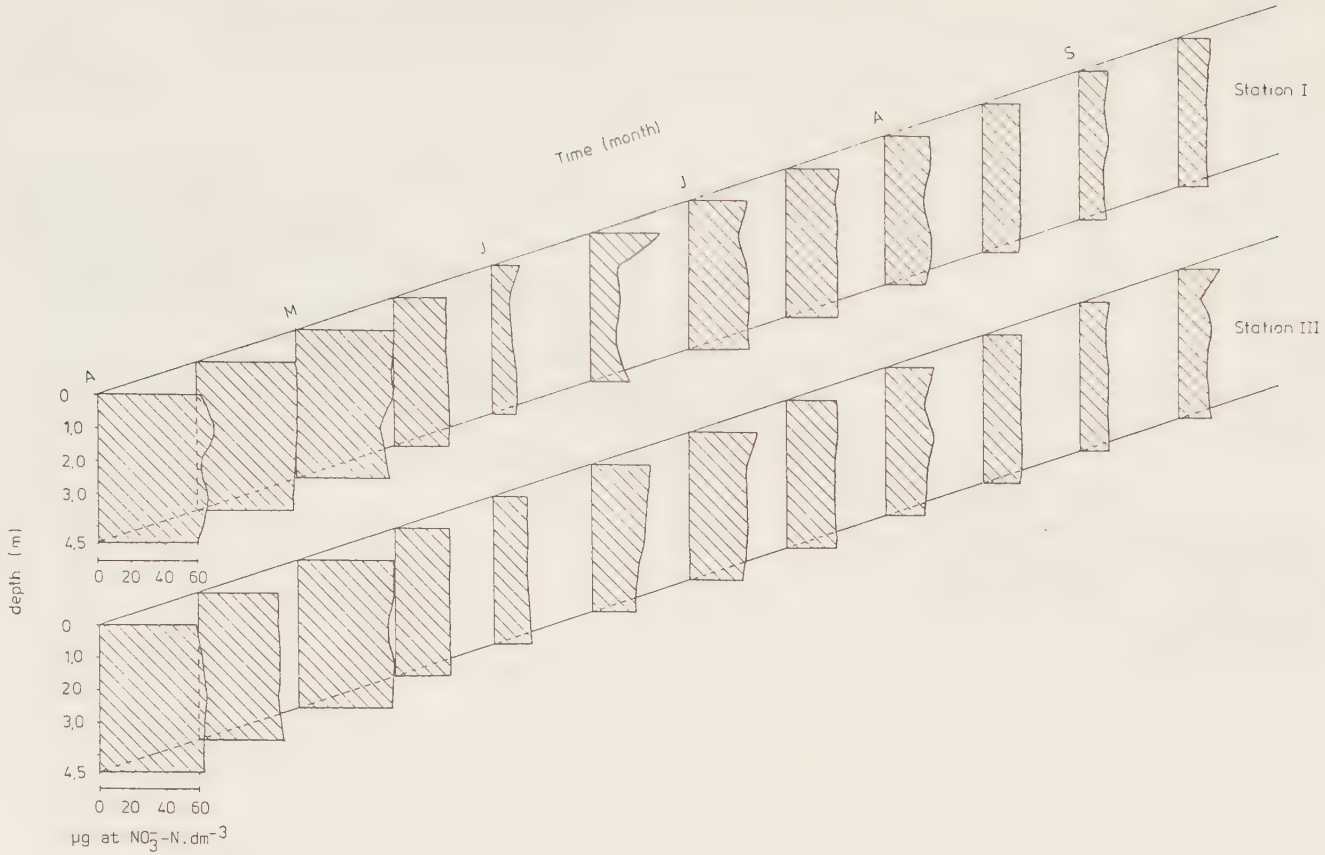

Fig. 8c - Seasonal variation of nitrate at Station I and Station III in the Bostal Reservoir for the year 1984.

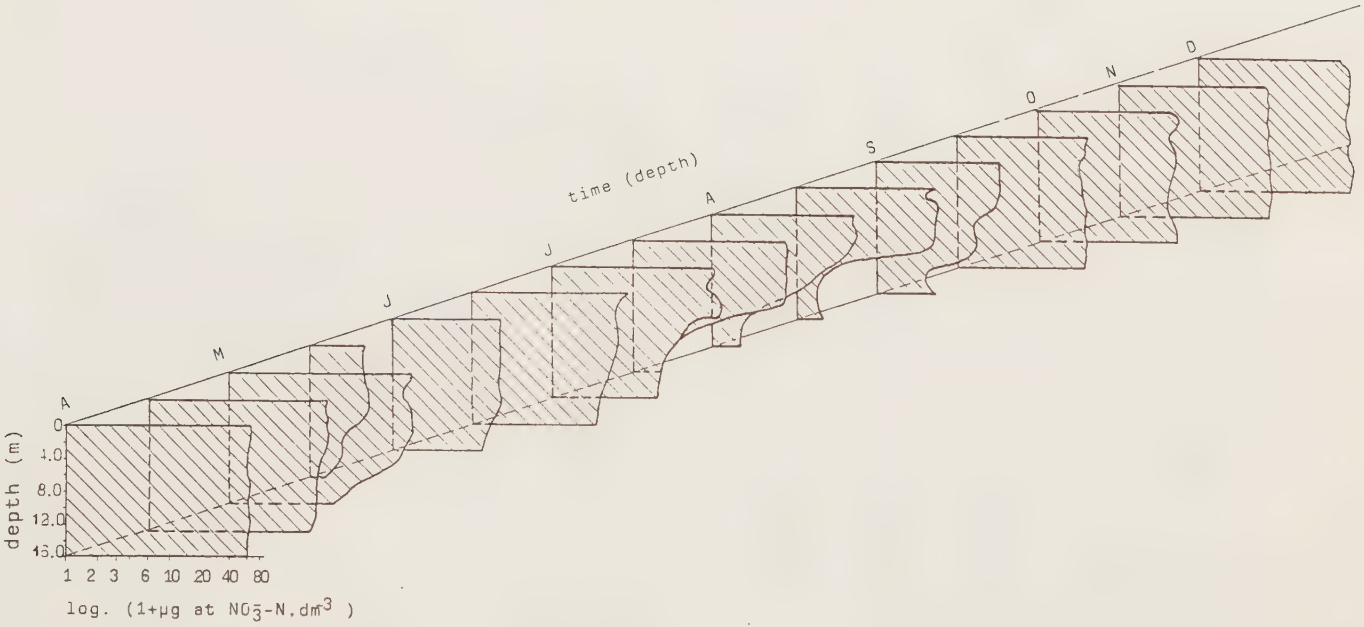

Fig. 8d - Seasonal variation of nitrate at Station II in the Bostal Reservoir for the year 1984.

days. During the winter months nitrate levels remained uniform and high in the water body.

The structure of organic nitrogen distribution in the studied area became variable horizontally, vertically and seasonally. The lowest organic nitrogen content was found on 14 Dec. 1984 at station II, at 3.0 m depth, while the highest value (152.10 µg at $N.dm^{-3}$) was found on 25 Aug. 1984 at station II, as well, however at 16.0 m depth. Of 470 samples investigated only 20 had less than 5 and as high as 374 had more than 15 µg at $N.dm^{-3}$. All results are shown in Fig. 9a, 9b, 9c and 9d. During the winter months sampled (Nov.-Dec.) only relatively small concentrations of organic nitrogen could be calculated at all depths, the same pattern could also be detected in April. After the relatively low winter values, a strong increase in the organic nitrogen content was detected by early June at all stations sampled. When the stratification became steady (early July), total organic nitrogen begun to accumulate in the hypolimnion reaching its maxima by the end of the stratification period. For the years 1983 and 1984 maximum values of 142.92 and 152.10 µg at $N.dm^{-3}$ were found respectively.

The distribution of total nitrogen is shown in Fig. 10a, 10b, 10c and 10d. The fluctuation of total nitrogen was similar to these of total organic nitrogen.

The average concentrations of total nitrogen and nitrogen fractions at various depths at the three sampled

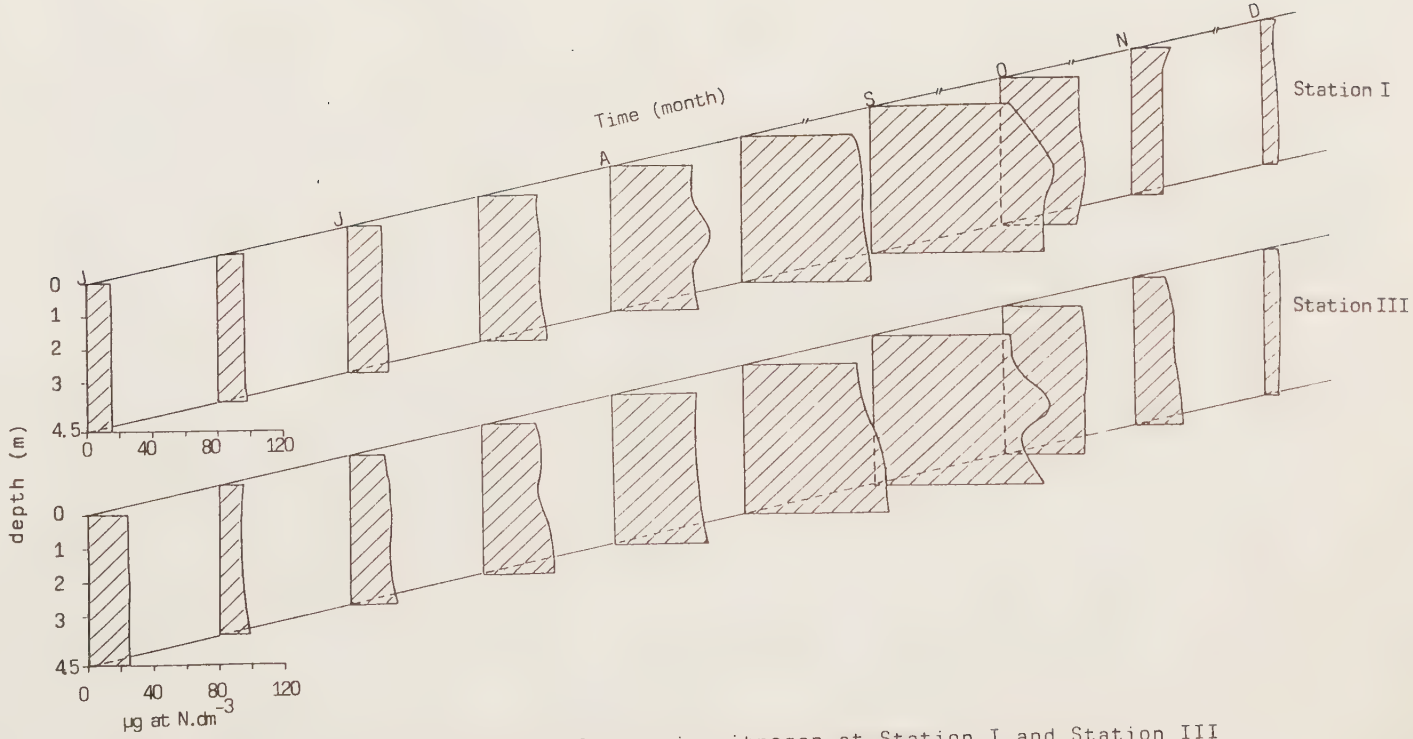

Fig. 9a - Seasonal variation of total organic nitrogen at Station I and Station III in the Bostal Reservoir fot the year 1983.

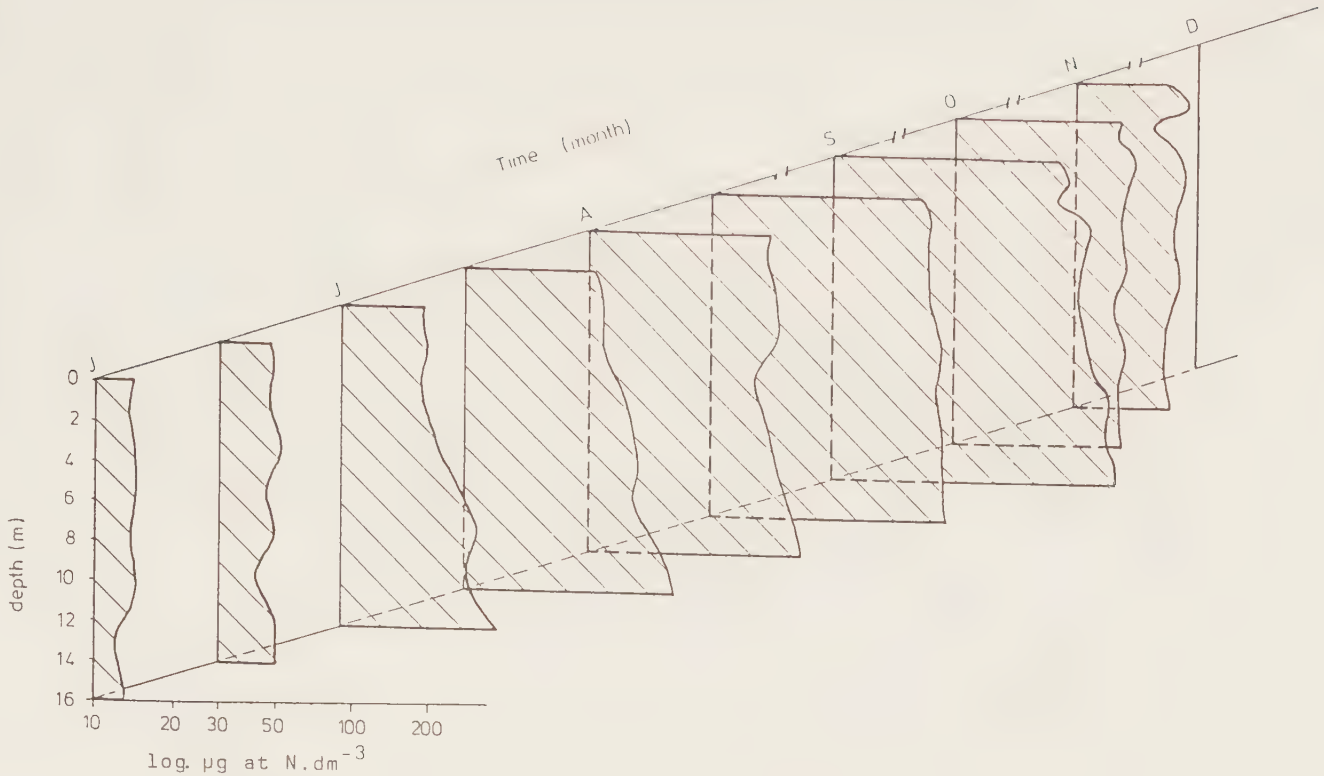

Fig. 9b - Seasonal variation of total organic nitrogen at Station II in the Bostal Reservoir for the year 1983.

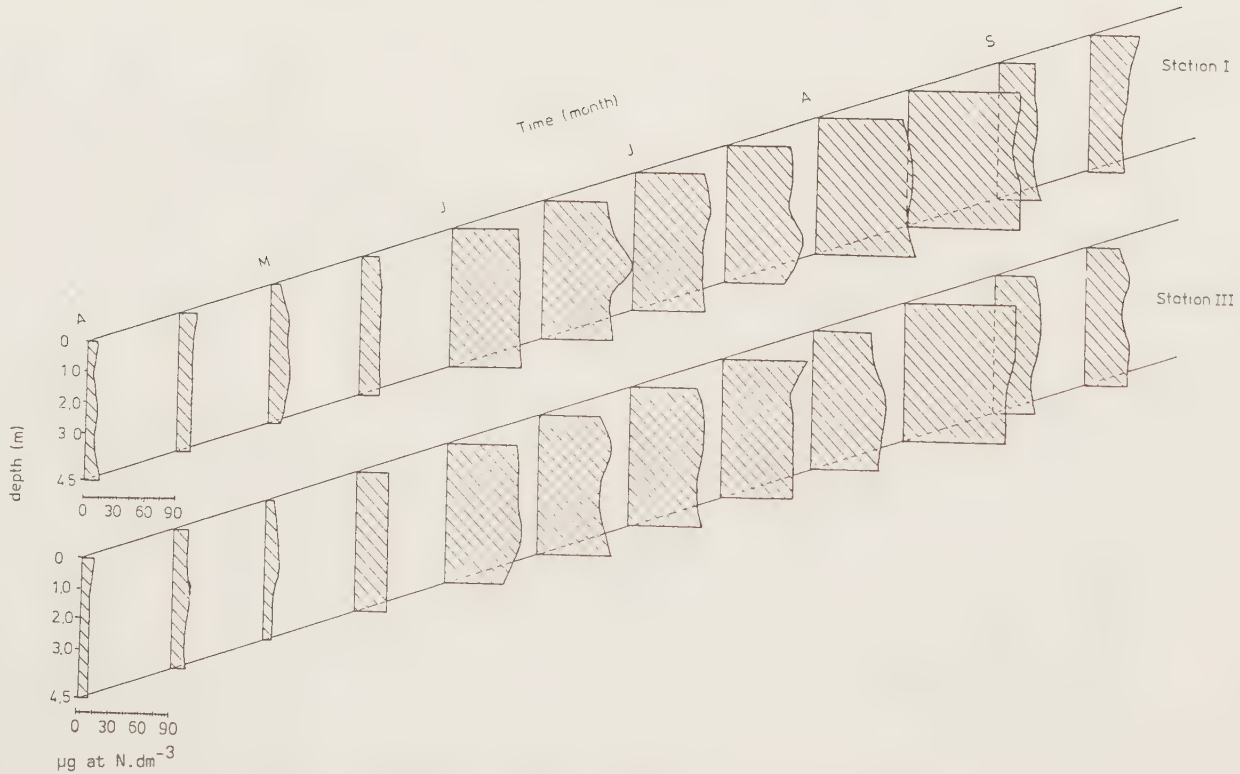

Fig. 9c - Seasonal variation of total organic nitrogen at Station I and Station III in the Bostal Reservoir for the year 1984.

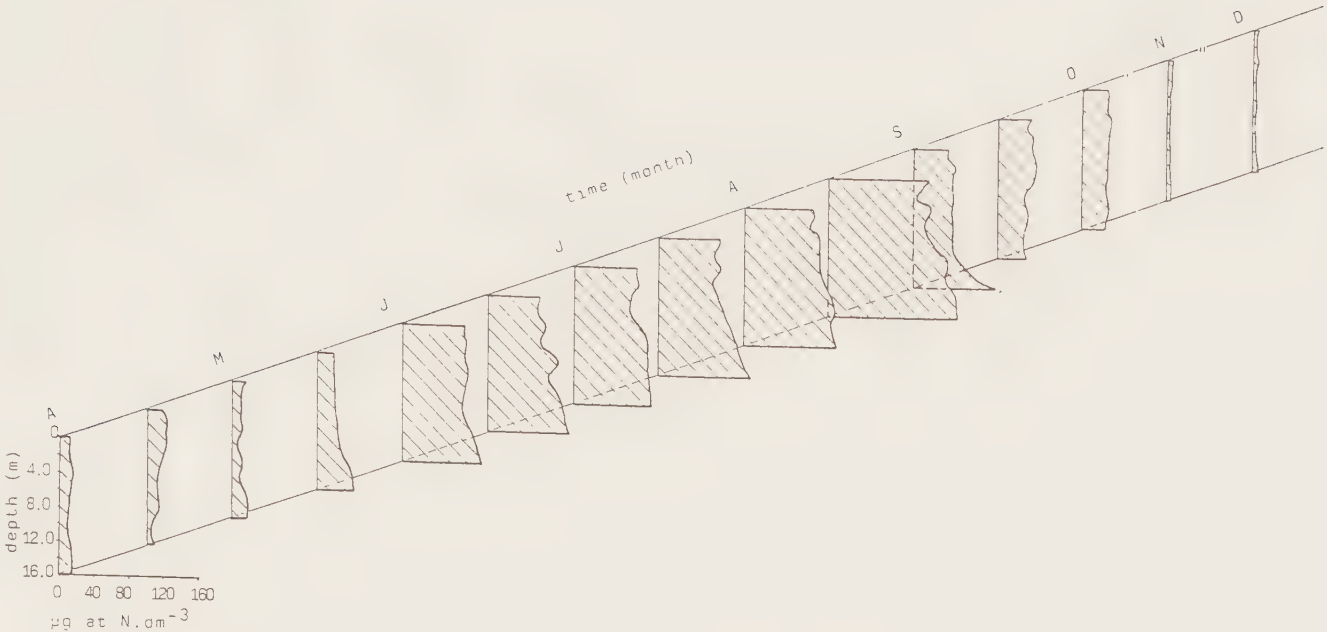

Fig. 9d - Seasonal variation of total organic nitrogen at Station II in the Bostal Reservoir for the year 1984.

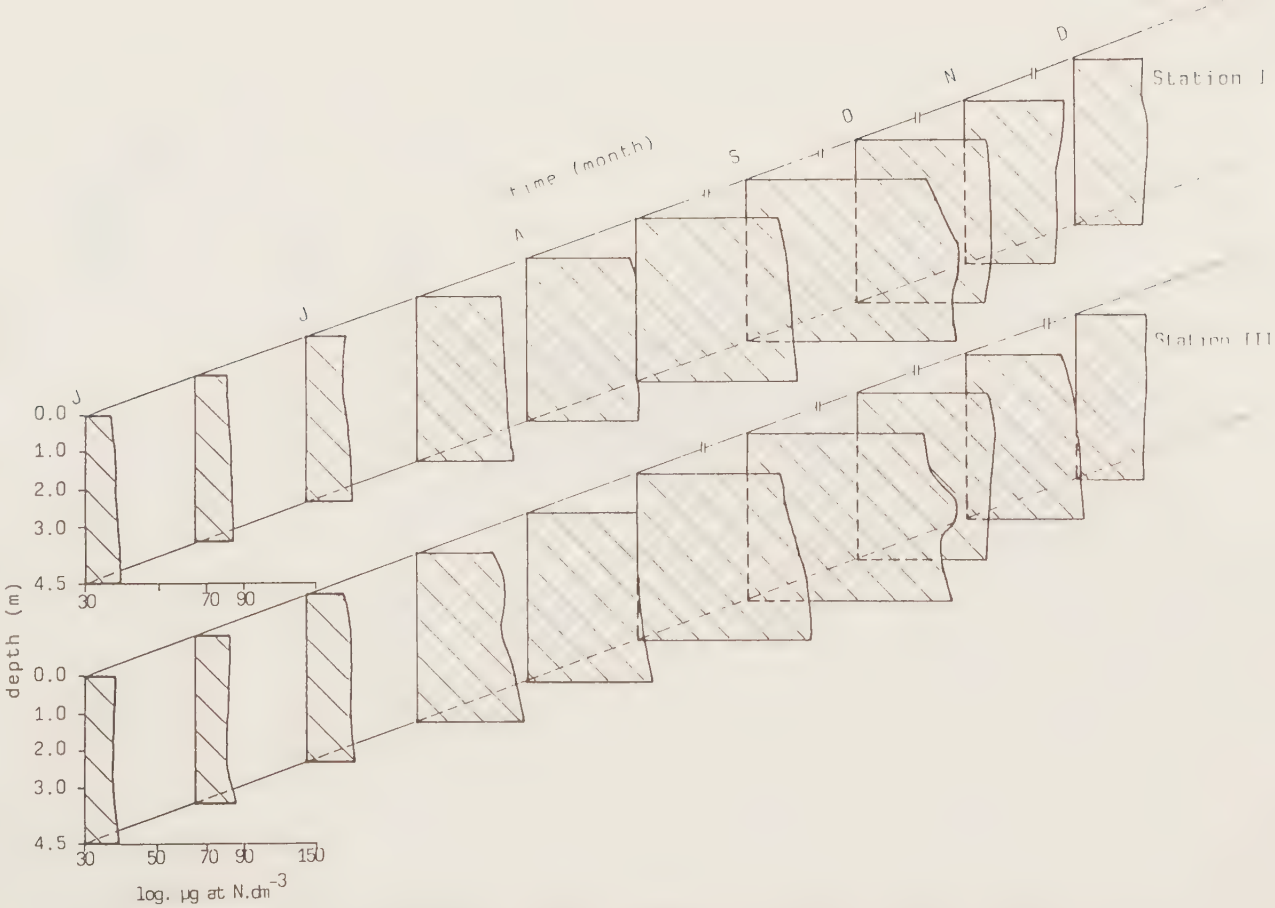

Fig. 10a - Seasonal variation of total nitrogen at Station I and Station III in the Bostal Reservoir for the year 1983.

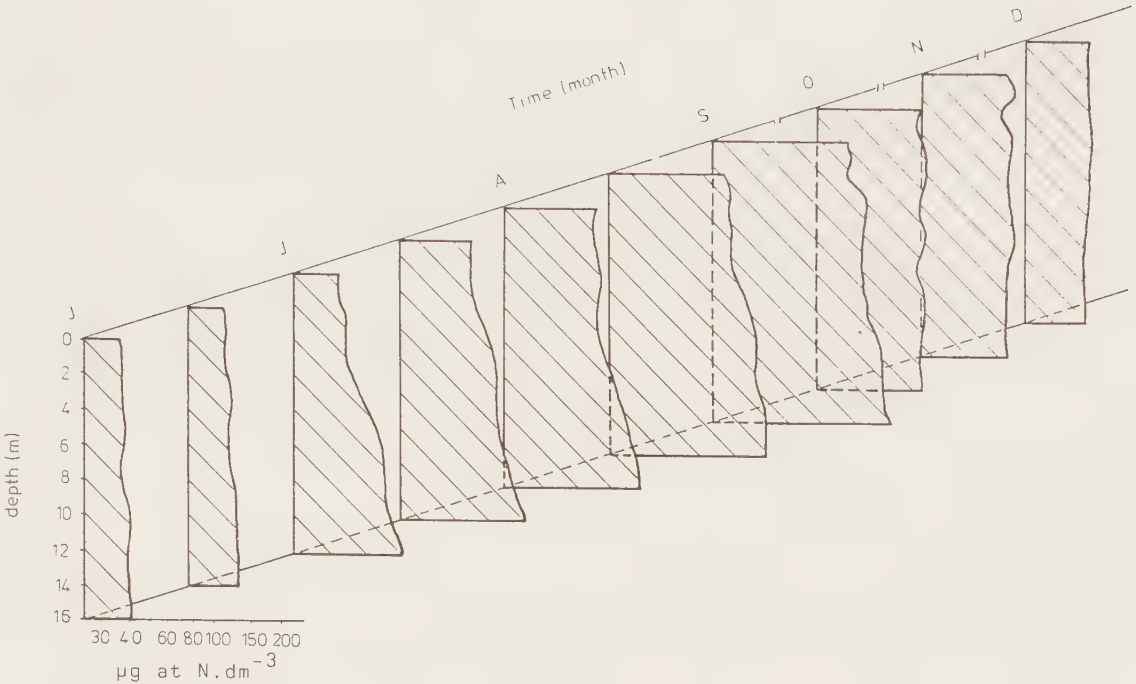

Fig. 10b - Seasonal variation of total nitrogen at Station II in the Bostal Reservoir for the year 1983.

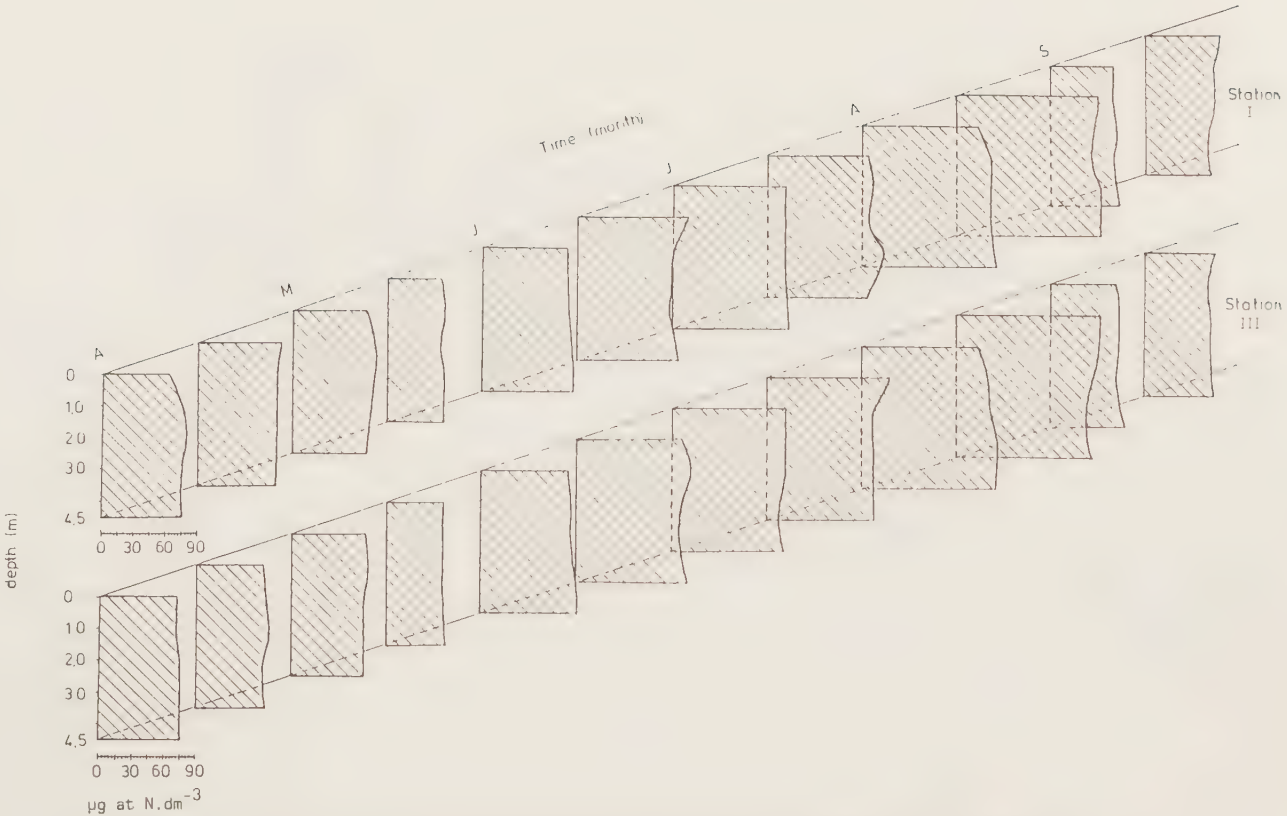

Fig. 10c - Seasonal variation of total nitrogen at Station I and Station III in the Bostal Reservoir for the year 1984.

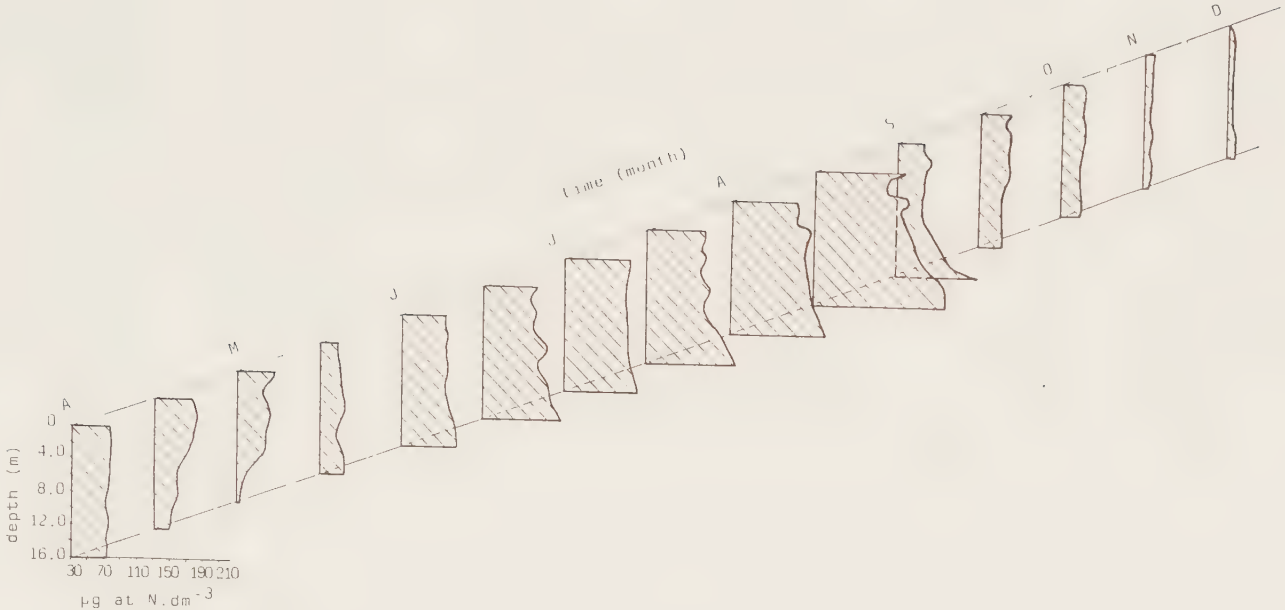

Fig. 10d - Seasonal variation of total nitrogen at Station II in the Bostal Reservoir for the year 1984.

stations are summarized in table II and III respectively.

Table II

Average concentrations of Total Nitrogen at various depths. Results represent samples collected at three stations on the Bostal Reservoir in the years 1983 and 1984.

	Concentration µg at $N.dm^{-3}$	
Depth (m)	1983	1984
0	$60.06^{+}/-20.99$	$83.32^{+}/-26.93$
1	$62.10^{+}/-23.15$	$82.74^{+}/-25.52$
2	$63.25^{+}/-25.95$	$82.77^{+}/-24.60$
3	$64.25^{+}26.04$	$83.57^{+}/-27.71$
5	$65.84^{+}/-26.65$	$84.78^{+}/-26.42$
7	$67.60^{+}/-26.11$	$80.35^{+}/-31.77$
9	$70.33^{+}/-27.15$	$78.42^{+}/-32.38$
11	$74.83^{+}/-31.70$	$81.35^{+}/-36.35$
13	$78.22^{+}/-34.62$	$85.17^{+}/-42.17$
16	$84.86^{+}/-38.42$	$90.61^{+}/-47.61$

$^{+}/-$ = Standard error

Ammonium was always present in the water column, however there was a substantial depth gradient of ammonium concentration in both years, where very low values were found near the surface, and high values in the deeper layers.

The amount of nitrite was kept exccendigly low during the study, and represented < 1 percent of the total nitro-

gen. From the three inorganic fractions nitrate was the dominant form. In fact, nitrate accounted for most of the inorganic pool both years and made up 17-43 percent of the total nitrogen.

Table III

Average concentrations of nitrogen fractions at various depths. Results represent samples collected at three stations on the Bostal Reservoir in the years 1983 and 1984.

	Concentration / dm^3							
	Ammonium	Nitrate	Nitrite	Org.N	Ammonium	Nitrate	Nitrite	Org.N
	µg at NH_4^+	µg at NO_3^-	µg at NO_2^-	µg at N	µg at NH_4^+	µg at NO_3^-	µg at NO_2^-	µg at N
Depth(m)	1983				1984			
0	3.91	18.51	0.40	37.26	2.38	33.66	0.32	46.41
1	3.92	18.59	0.42	39.25	2.08	32.39	0.33	47.15
2	4.10	18.43	0.43	40.64	2.29	35.29	0.33	47.34
3	4.18	18.70	0.40	40.98	2.32	31.98	0.32	48.03
5	4.63	18.19	0.41	42.61	2.57	32.30	0.32	48.31
7	7.43	18.20	0.41	41.97	4.53	28.53	0.29	46.77
9	8.96	17.34	0.46	43.56	5.49	24.37	0.38	48.05
11	11.91	16.31	0.45	45.84	8.73	21.70	0.36	49.97
13	15.26	15.39	0.48	47.08	11.90	19.11	0.38	53.88
16	16.77	14.54	0.49	53.05	12.92	16.84	0.51	54.89

Total organic nitrogen was always an important component of the total nitrogen pool. In 1983 its percentage contribution to total nitrogen was slightly lower than in 1984; the

grand average for the 2 years was ca. 60 percent. Absolute levels of total organic nitrogen in 1983 were considerably higher at all depths than in 1984.

In order to confirm differences between year averages for nitrogen a ANOVA test was accomplished. The ANOVA results endorses statistically the difference between years in oncentration of total organic nitrogen, total N, nitrite and nitrate. However the ANOVA test did not confirm statistically the difference in average ammonium concentration between years ($p < 0.01$).

The soluble reactive phosphorus concentrations were always relatively very small and varied through the entire period of study between 0.20 and 7.15 µg at PO_4^{-3}-P.dm^{-3}. Out of 490 samples analysed only 24 values were higher than 1 µg at PO_4^{-3}-P.dm^{-3}. Taken as a whole soluble reactive phosphorus were slightly higher in the winter than in the summer (See Fig. 11a, 11b, 11c and 11d). During the period studied we have never detected any strong fluctuation throughout the seasons in the Bostal Reservoir. The soluble reactive phosphorus in the Bostal Reservoir at the three sampled stations did not show any markedly variation during the sampling period.

Over the period studied the concentrations of total phosphorus and total dissolved phosphorus were usually relatively small. Although some winter values for total phosphorus and total dissolved P, as well, were slightly higher than some ones, one does not have here sufficient indica-

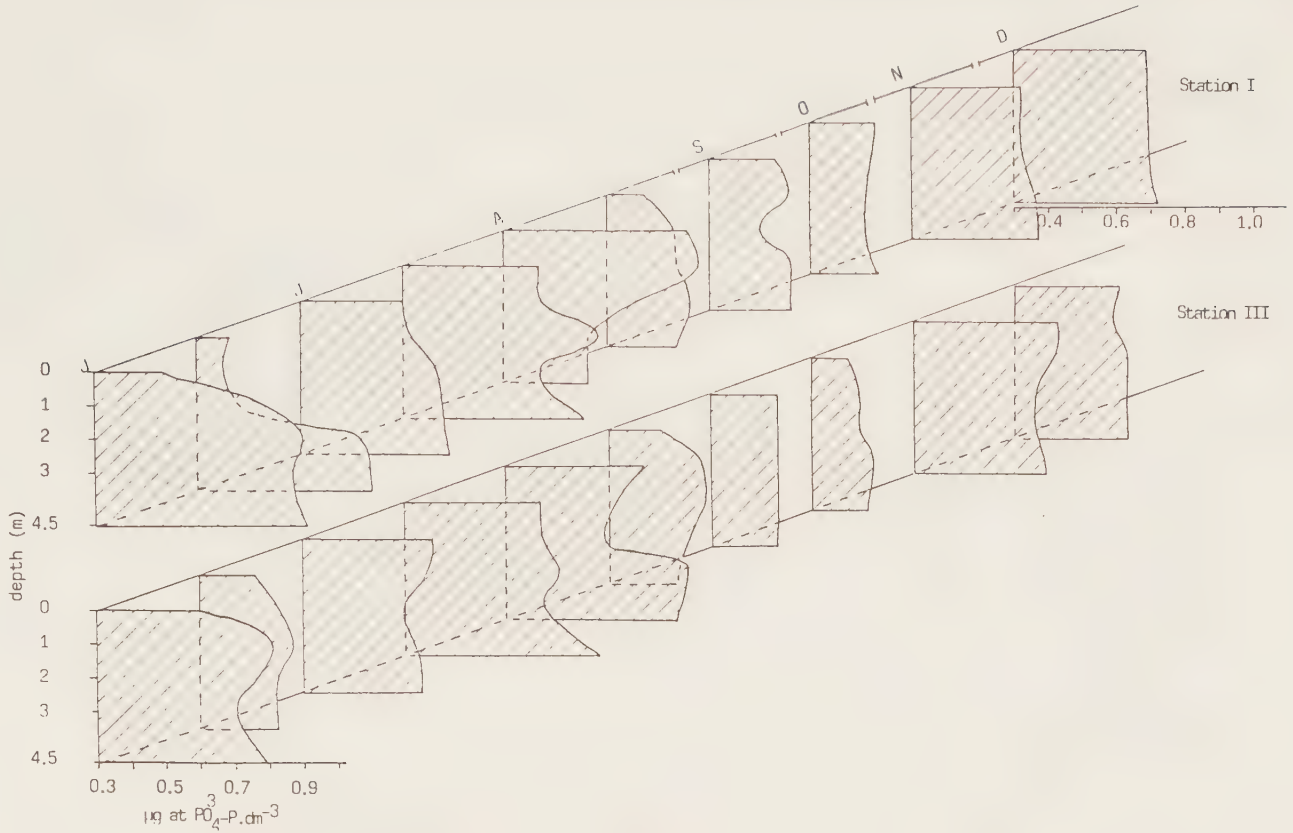

Fig. 11a - Seasonal variation of soluble reactive phosphorus at Station I and Station III in the Bostal Reservoir for the year 1983.

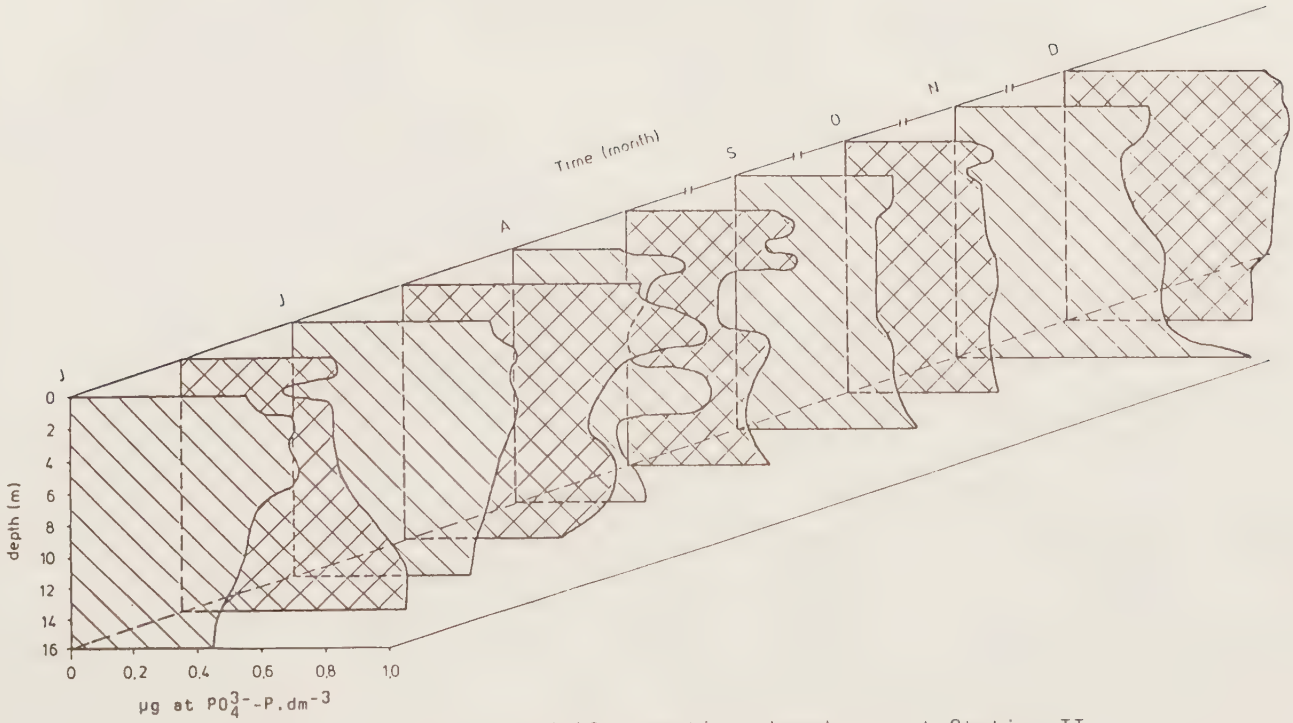

Fig. 11b - Seasonal variation of soluble reactive phosphorus at Station II in the Bostal Reservoir for the year 1983.

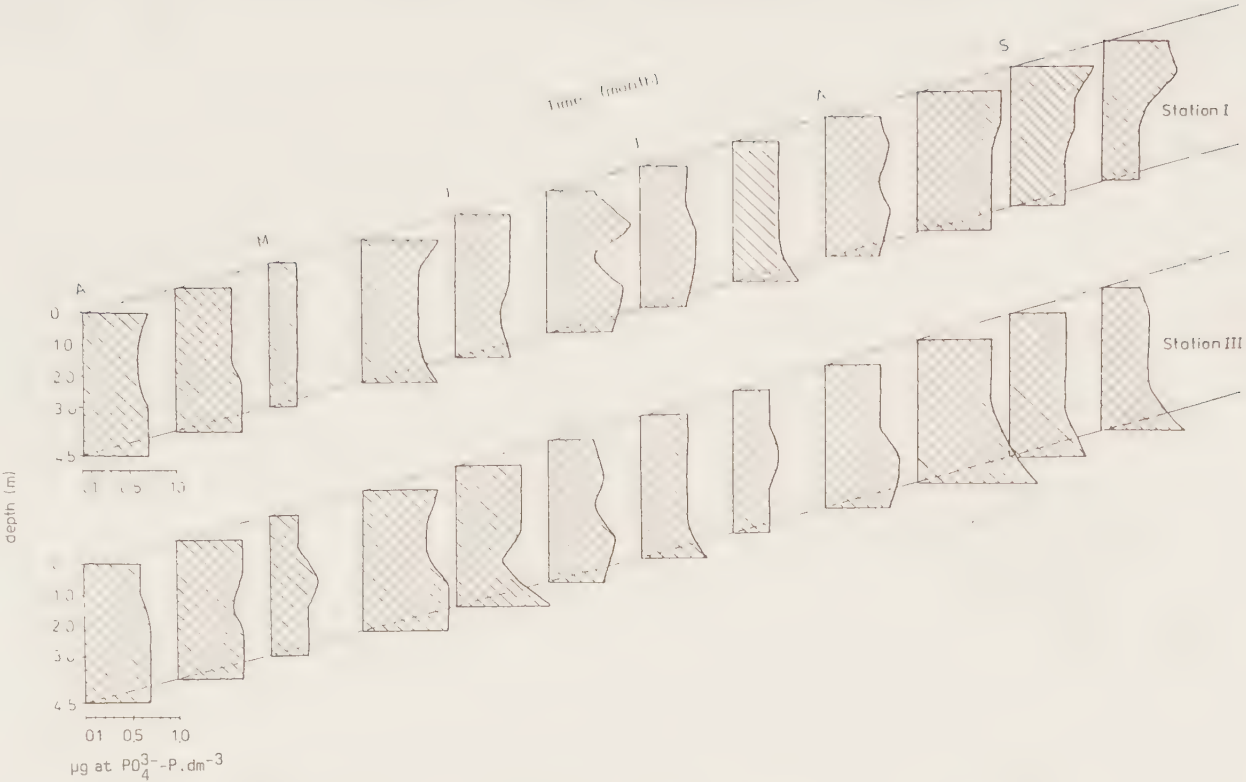

Fig. 11c - Seasonal variation of soluble reactive phosphorus at Station I and Station III in the Bostal Reservoir for the year 1984.

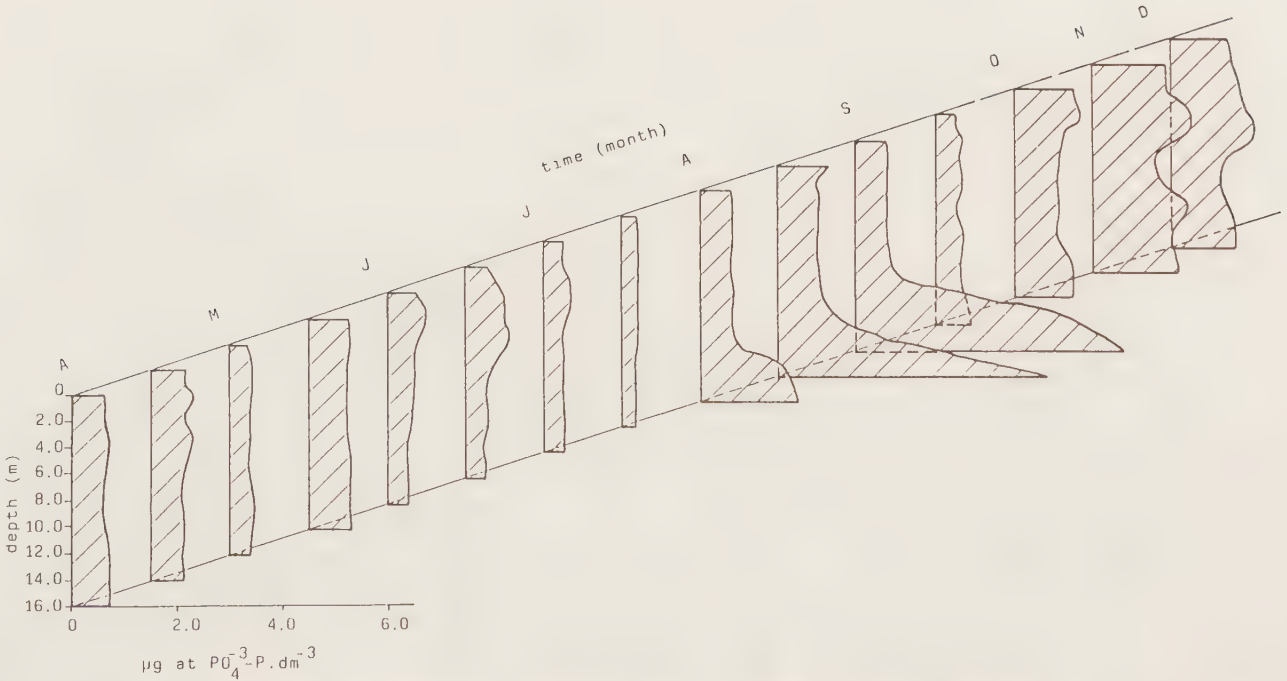

Fig. 11d - Seasonal variation of soluble reactive phosphorus at Station II in the Bostal Reservoir for the year 1984.

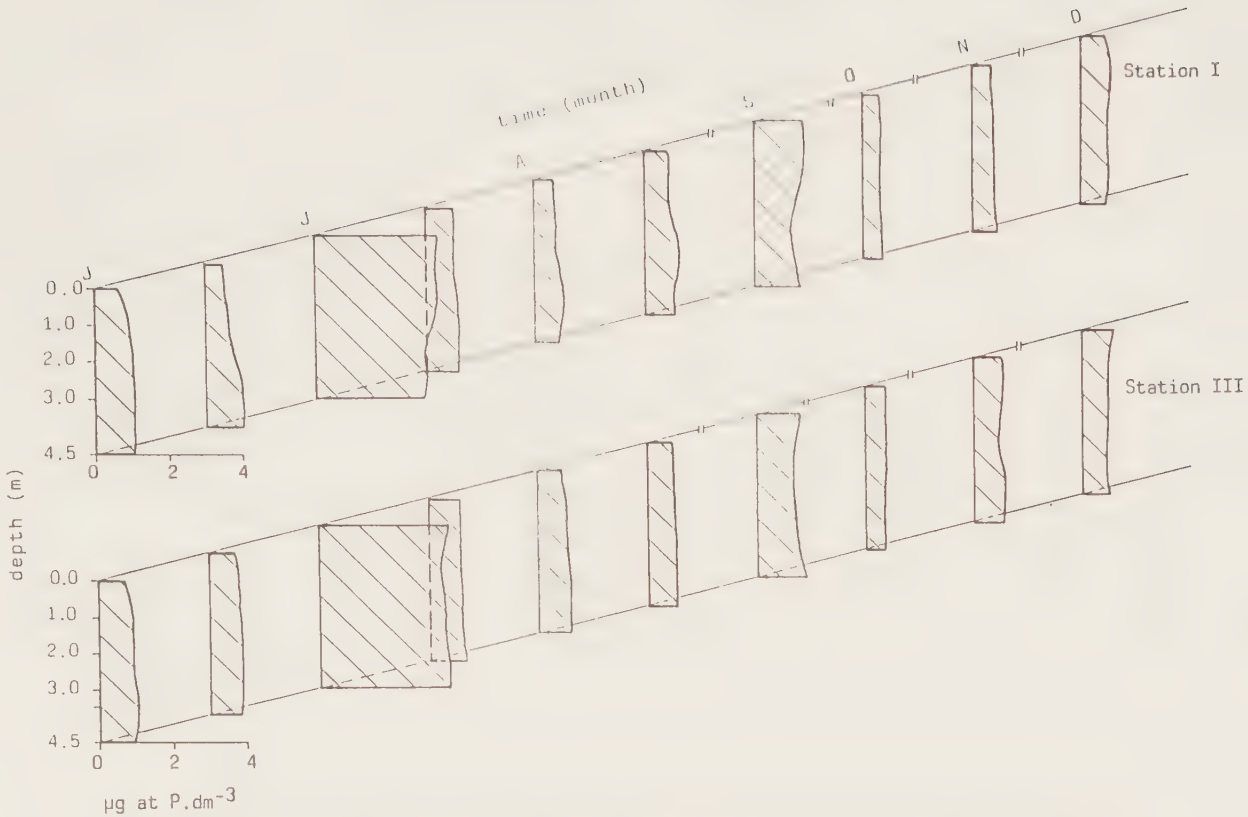

Fig. 12a - Seasonal variation of total dissolved phosphorus at Station I and Station III in the Bostal Reservoir for the year 1983.

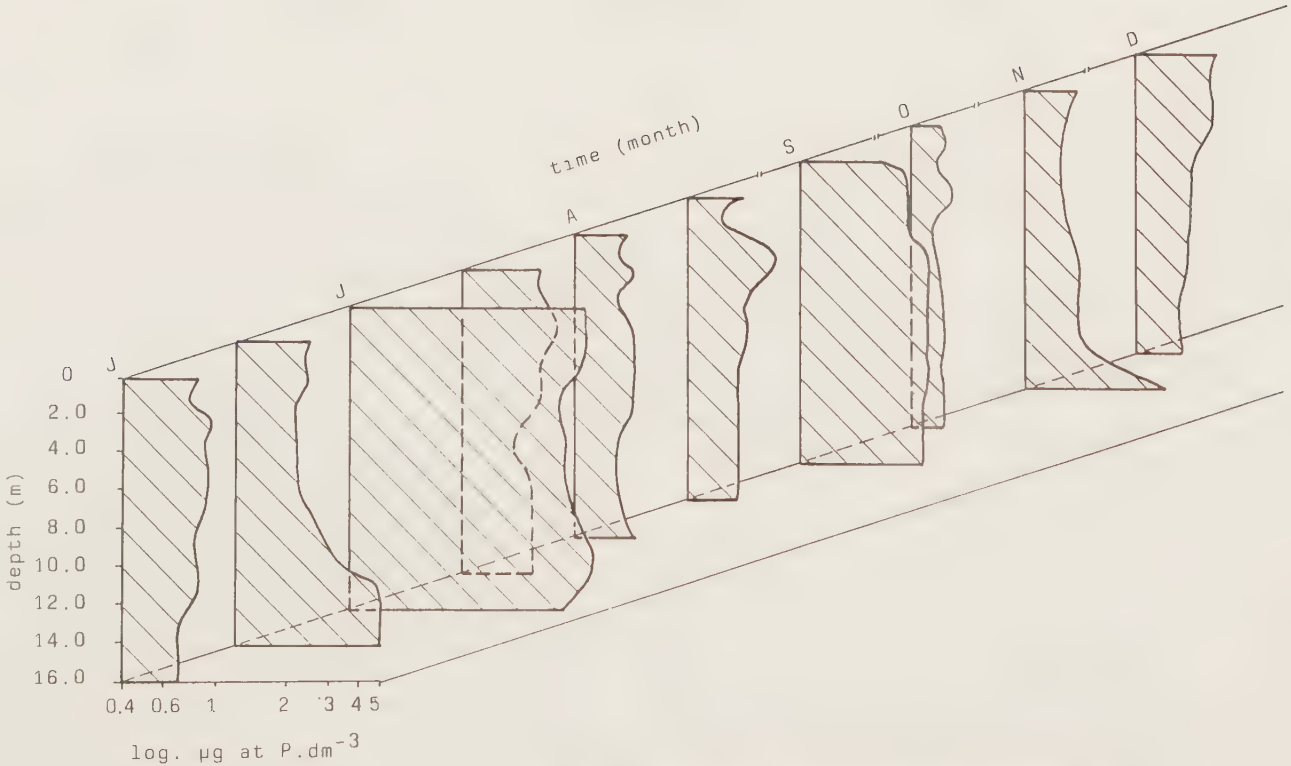

Fig. 12b - Seasonal variation of total dissolved phosphorus at Station II in the Bostal Reservoir for the year 1983.

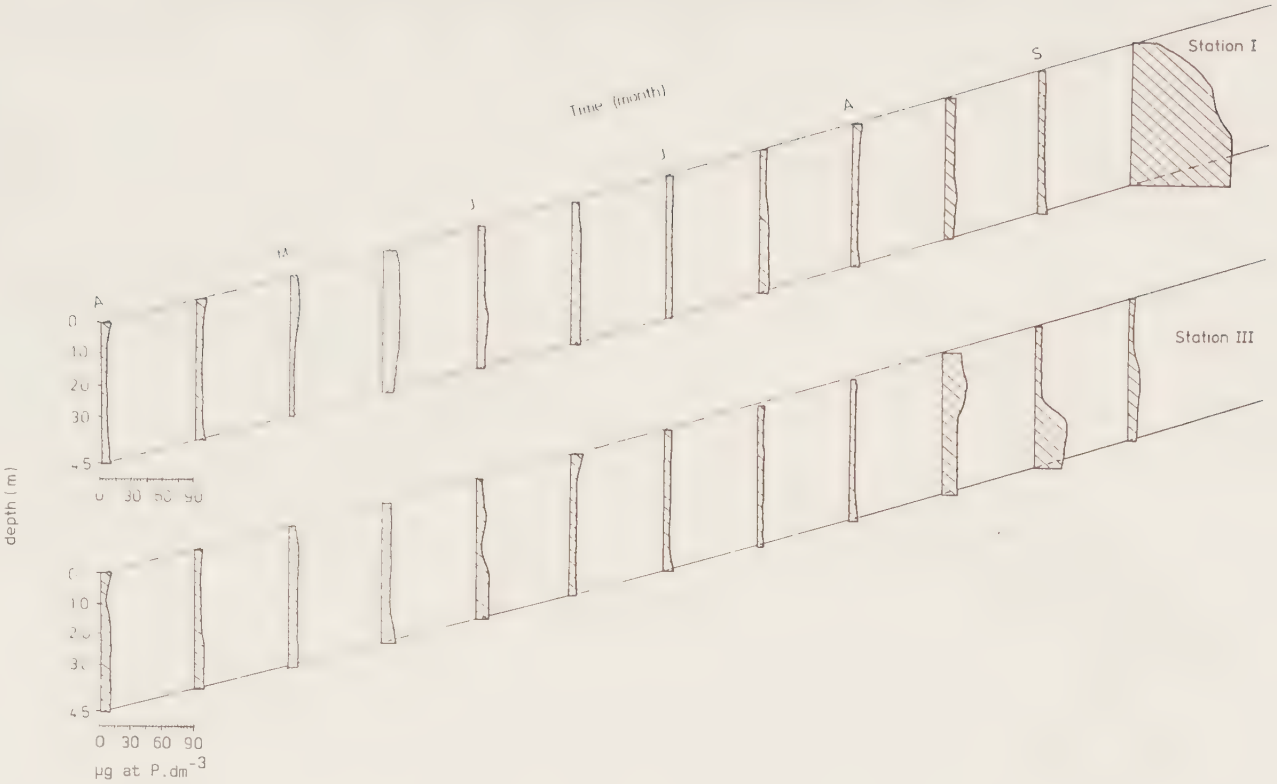

Fig. 12c - Seasonal variation of total dissolved phosphorus at Station I and Station III in the Bostal Reservoir for the year 1984.

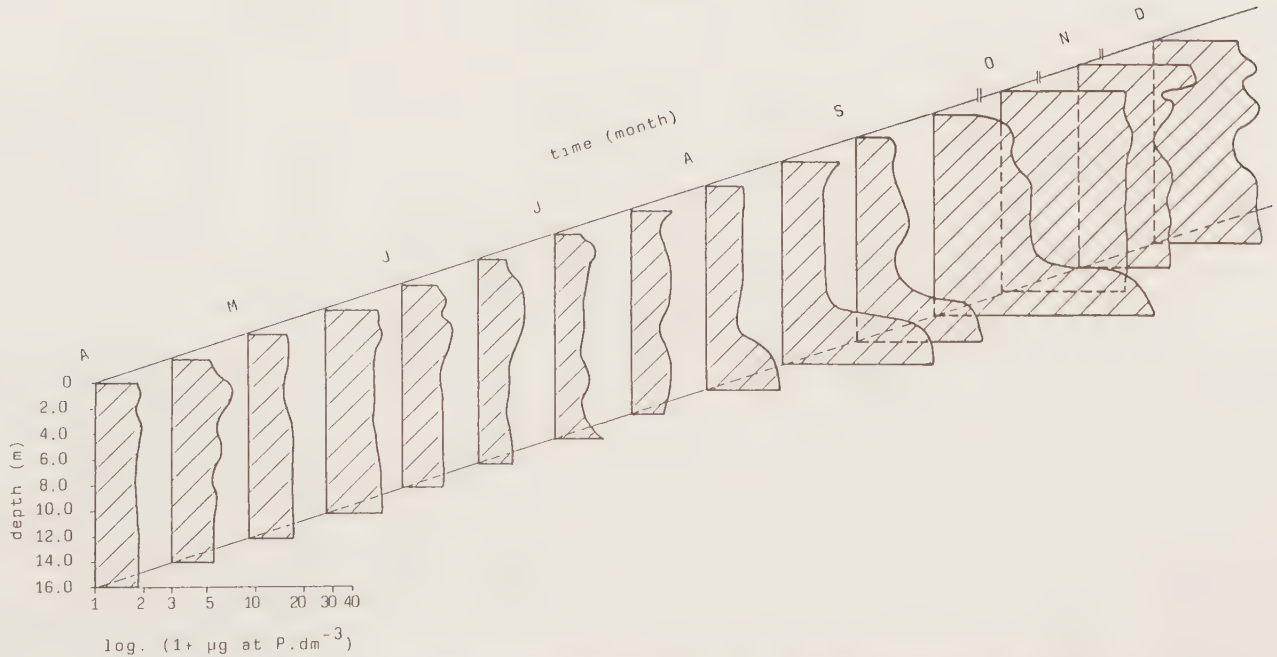

Fig. 12d - Seasonal variation of total dissolved phosphorus at Station II in the Bostal Reservoir for the year 1984.

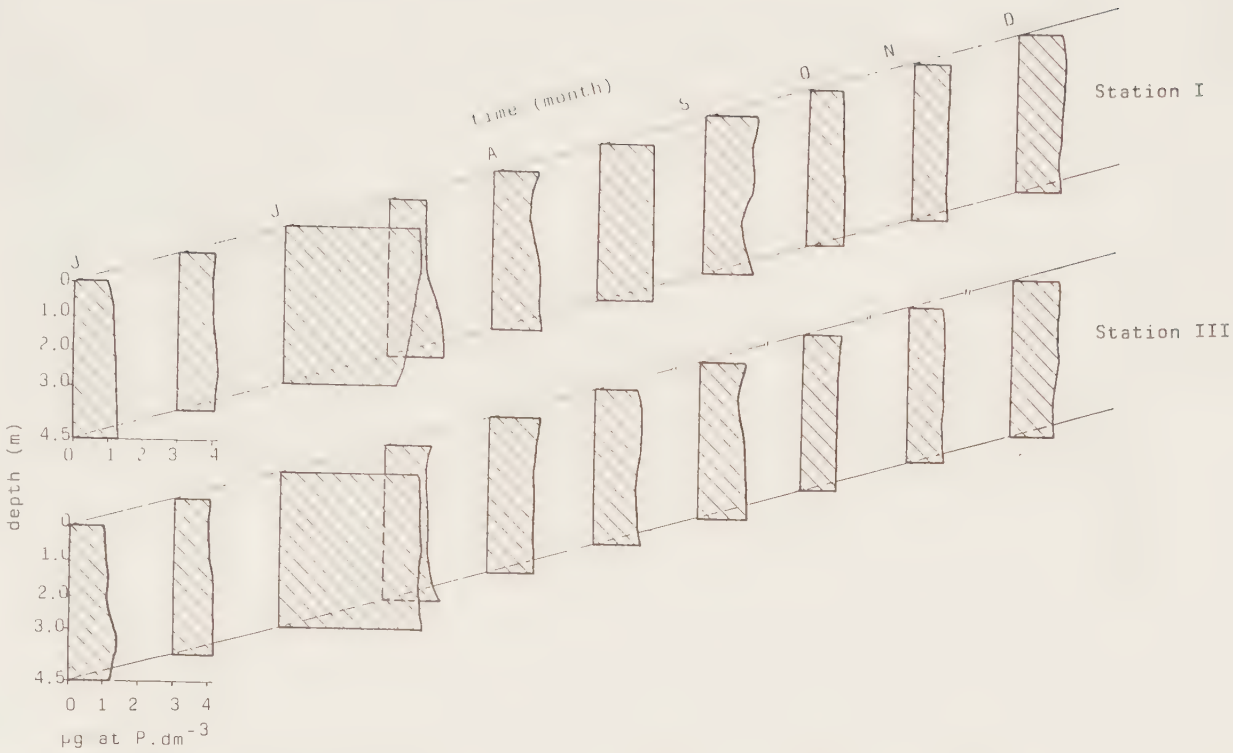

Fig. 13a - Seasonal variation of total phosphorus at Station I and Station III in the Bostal Reservoir for the year 1983.

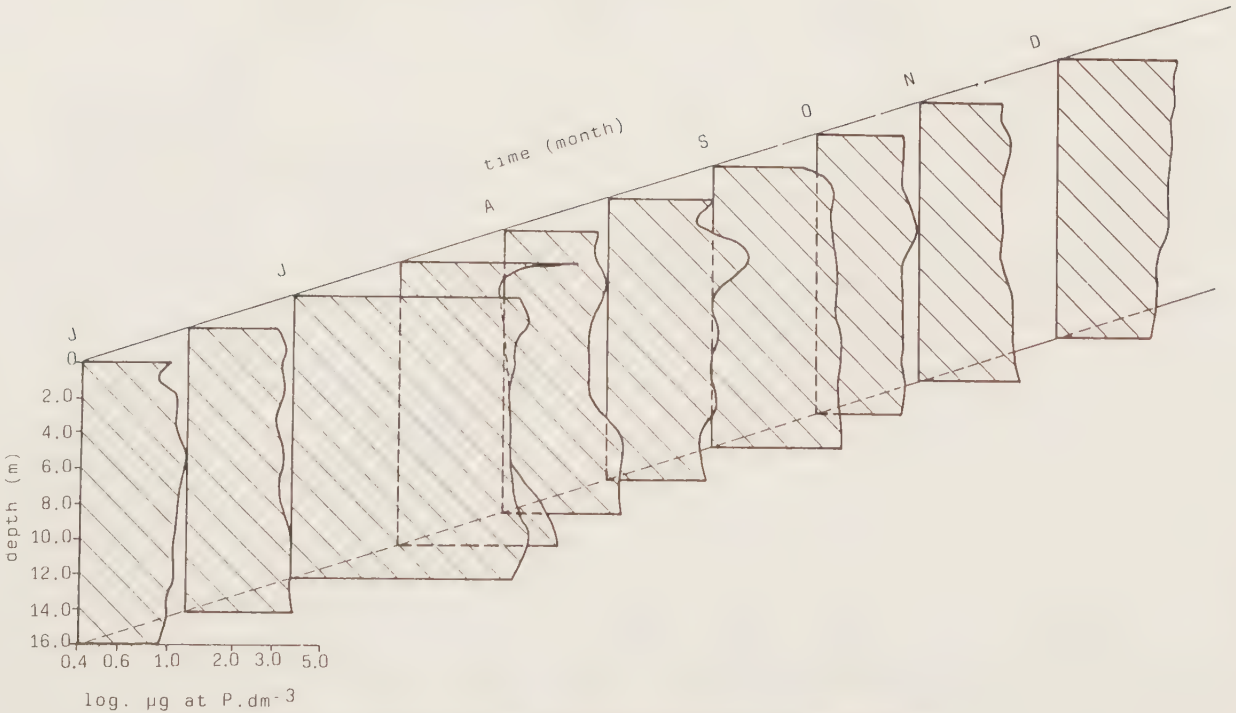

Fig. 13b - Seasonal variation of total phosphorus at Station II in the Bostal Reservoir for the year 1983.

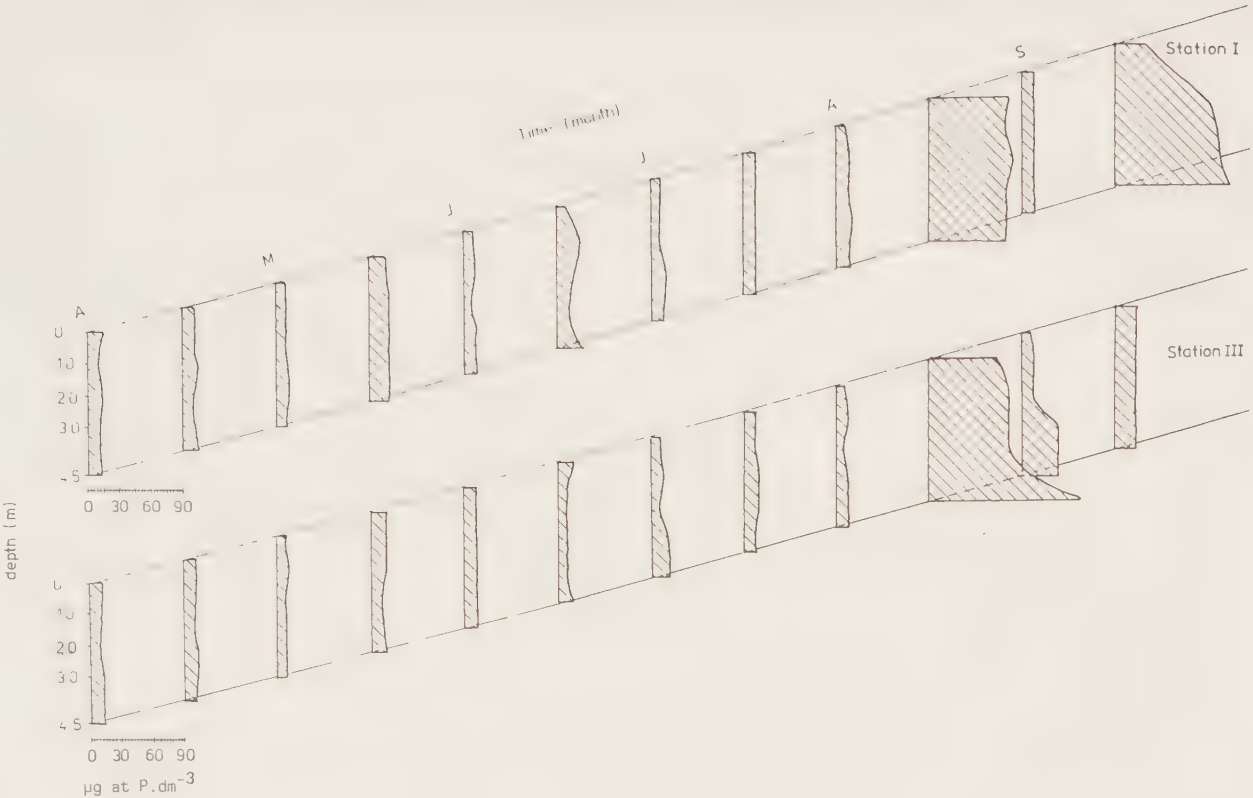

Fig. 13c - Seasonal variation of total phosphorus at Station I and Station III in the Bostal Reservoir for the year 1984.

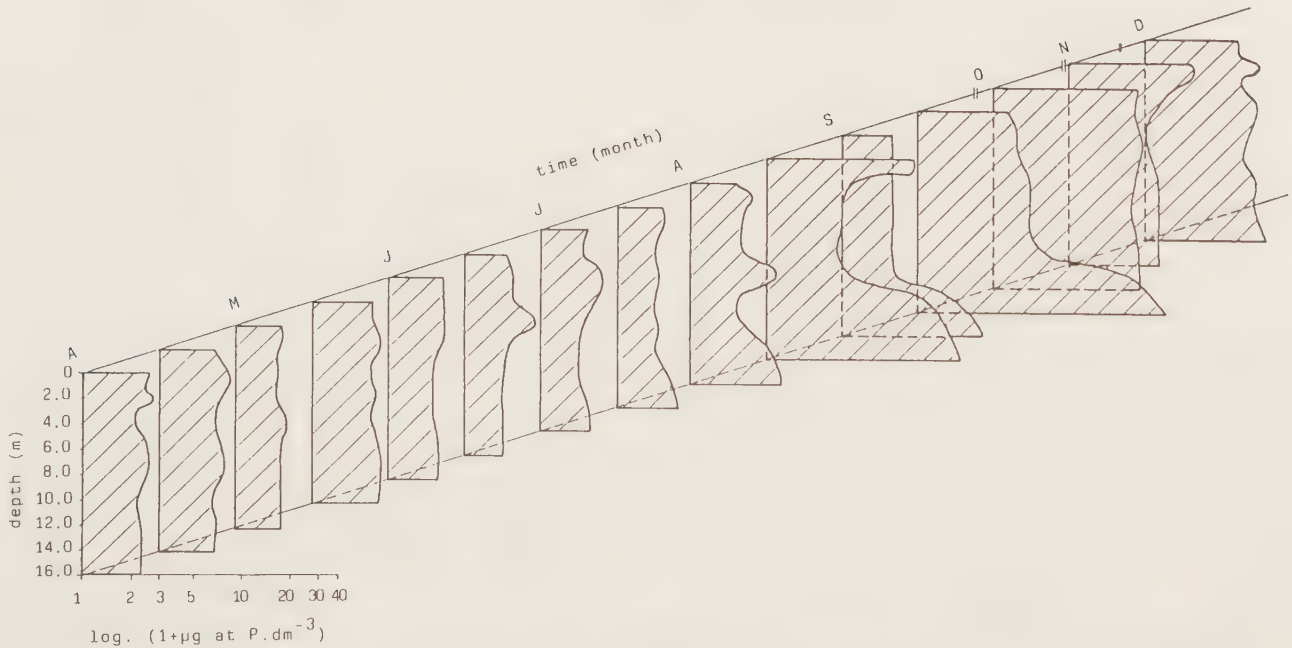

Fig. 13d - Seasonal variation of total phosphorus at Station II in the Bostal Reservoir for the year 1984.

tion of an yearly cycle. The results for total dissolved P and and total P for the period investigated are shown in Fig. 12a, 12b, 12c, 12d, 13a, 13b, 13c and 13d respectively. Of 470 samples analysed 295 had less than 1.5 and only 34 had more than 5.0 µg at $P.dm^{-3}$. The lowest total phosphorus and total dissolved phosphorus concentrations with 0.70 and 0.29 µg at $P.dm^{-3}$ were found on 10 07 84 and 10 05 84 respectively. The maximum value for total P concentration (39 µg at $P.dm^{-3}$) was found at station II at 16 m on 25 09 84, at the end of the stratification period. While there never was a complete disappearance of phsophorus at the three stations investigated, in late spring and sommer, more or less long periods of small P concentrations could be detected. Extremely high total P values were found on 4 July 1983 and 23 August 1984 through the whole water column. Such values are considerably higher than annual average values for total P and total dissolved P.

The concentrations of total phosphorus and the contributions of total dissolved P and soluble reactive P are summarized in Table IV.

The average soluble reactive phosphorus (SRP) values were very low in both years and showed only in the year 1984 an increasing trend with the depth. The average results for 1984 were slightly higher than these for 1983. The average results for total dissolved P were very much similar to those of SRP. However, total dissolved P avera-

ge results for 1984 were considerably higher than these of 1983, furthermore, 1984 average values showed a clear increasing trend towards higher depths, that did not occur with the values for 1983. Total P average results offered a similar picture to the total dissolved P, with higher values also for 1984, and a clear tendency toward higher values near the bottom, especially in 1984.

Table IV

Average concentrations of Total Phosphorus and Phosphorus fractions at various depths. Results represent samples collected at three stations on the Bostal Reservoir in the years 1983 and 1984.

	Concentration					
	SOLUBLE REACTIVE P		TOTAL DISSOLVED P		TOTAL P	
Depth (m)	1983	1984	1983	1984	1983	1984
0	0.56	0.63	1.04	1.09	1.48	2.05
1	0.60	0.72	1.06	1.29	1.45	2.26
2	0.60	0.65	0.95	1.28	1.48	2.25
3	0.61	0.66	1.09	1.43	1.51	2.23
5	0.61	0.70	1.07	1.41	1.51	2.50
7	o.52	0.68	1.04	1.47	1.45	2.17
9	0.56	0.64	1.02	1.47	1.45	2.03
11	0.54	0.74	1.09	1.56	1.46	2.57
13	0.53	1.08	1.14	3.29	1.61	4.23
16	0.56	1.39	1.09	4.16	1.60	5.90

Total P and P fractions were tested for statistically significant differences between years using a analysis of variance test (ANOVA). The average annual results differed significantly ($p < 0.05$) for SRP and total dissolved P, however at a level of $p < 0.01$ both fractions were not significantly different. On the other hand, a highly significant difference for total P was found between the years ($p < 0.01$).

The variation in the amount of chl. a over time and depth is shown if Fig. 14a, 14b, 14c and 14d together with transparency measurements. A maximum chl. a value was found in mid-April (21.16 µg chl. a.dm^{-3}). A glance at the distribution of chl. a at the three stations in the period studied will confirm the fact, that chl. a in the euphotic zone during such period showed a strong similarity. In 1984 during the spring mixing up of the water chl. a content values were found to be at their highest. A fortnight later chl. a values were as a whole considerably lower than for these of the second half of April. Chl. a went up again in June and remained high until the end of July. Actually, high values for chl. a were characteristc for the whole summer, until late August.

Regarding the integrated values for chl. a (Fig. 15) one may note that for the year 1984 two distinct peaks have been recorded, and after such peaks, the values for chl. a decreased quite rapidly. The July peak was not detected in 1983. However in both 1983 and 1984 after a

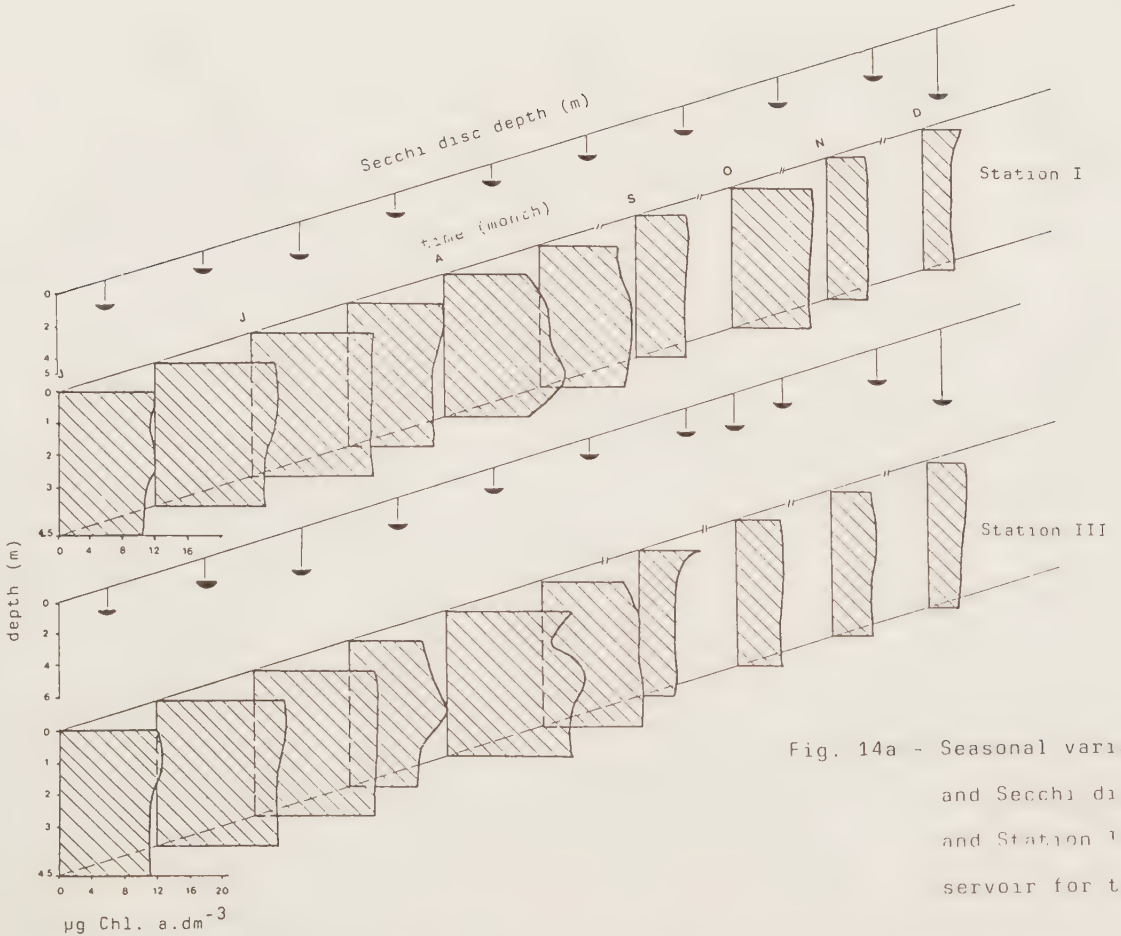

Fig. 14a - Seasonal variation of chlorophyll a and Secchi disc depth at Station I and Station III in the Bostal Reservoir for the year 1983.

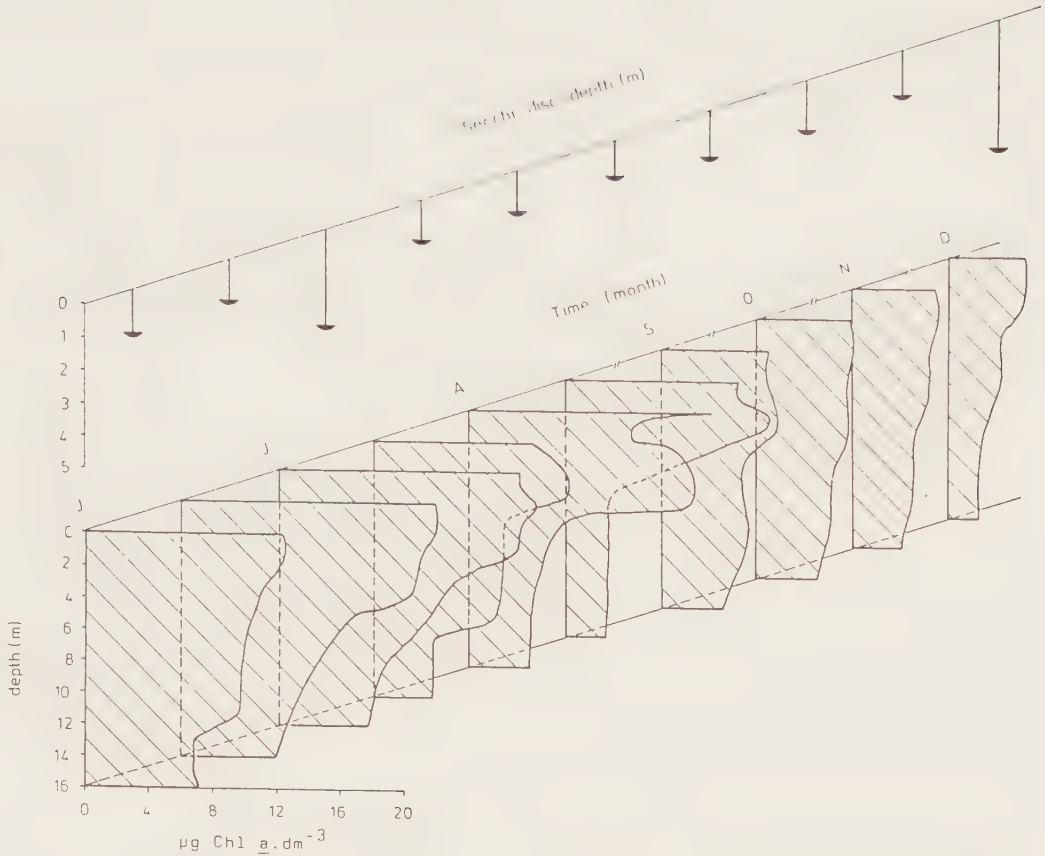

Fig. 14b - Seasonal variation of chlorophyll a and Secchi disc depth at Station II in the Bostal Reservoir for the year 1983.

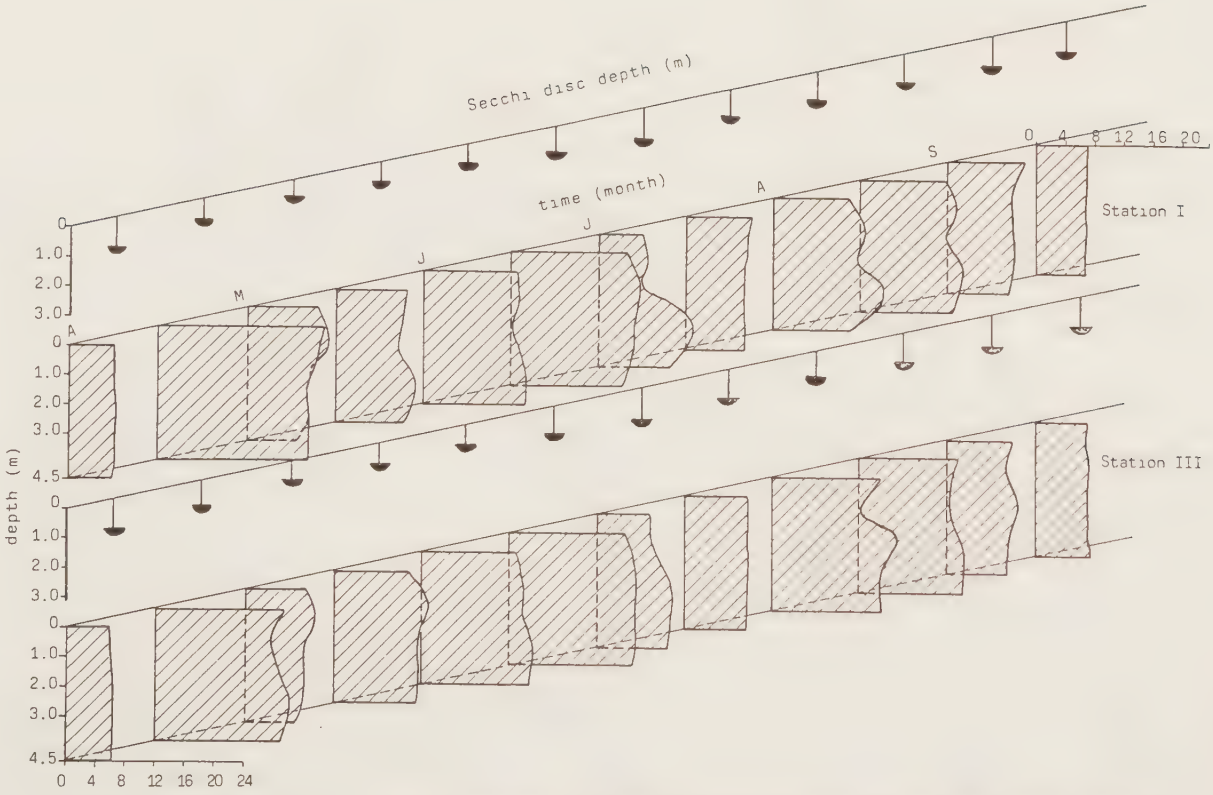

Fig. 14c - Seasonal variation of chlorophyll a and Secchi disc depth at Station I and Station III in the Bostal Reservoir for the year 1984.

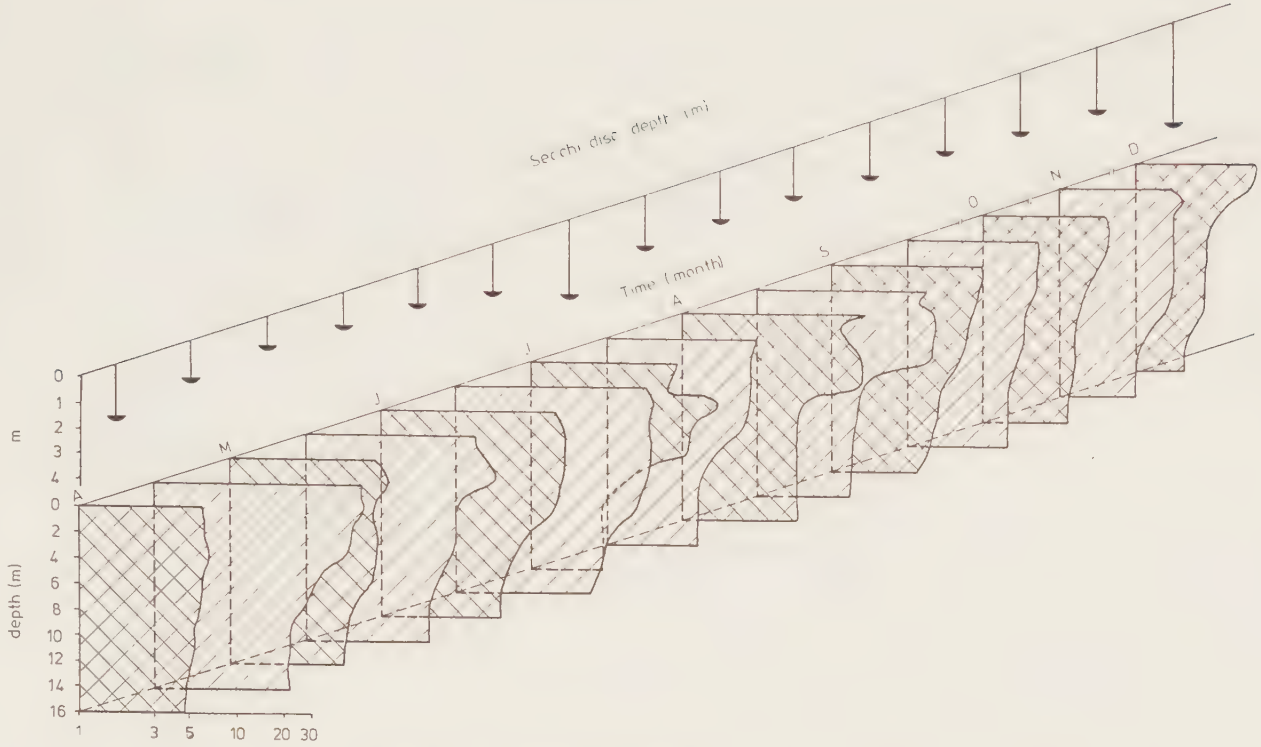

Fig. 14d - Seasonal variation of chlorophyll a and Secchi disc depth at Station II in the Bostal Reservoir for the year 1984.

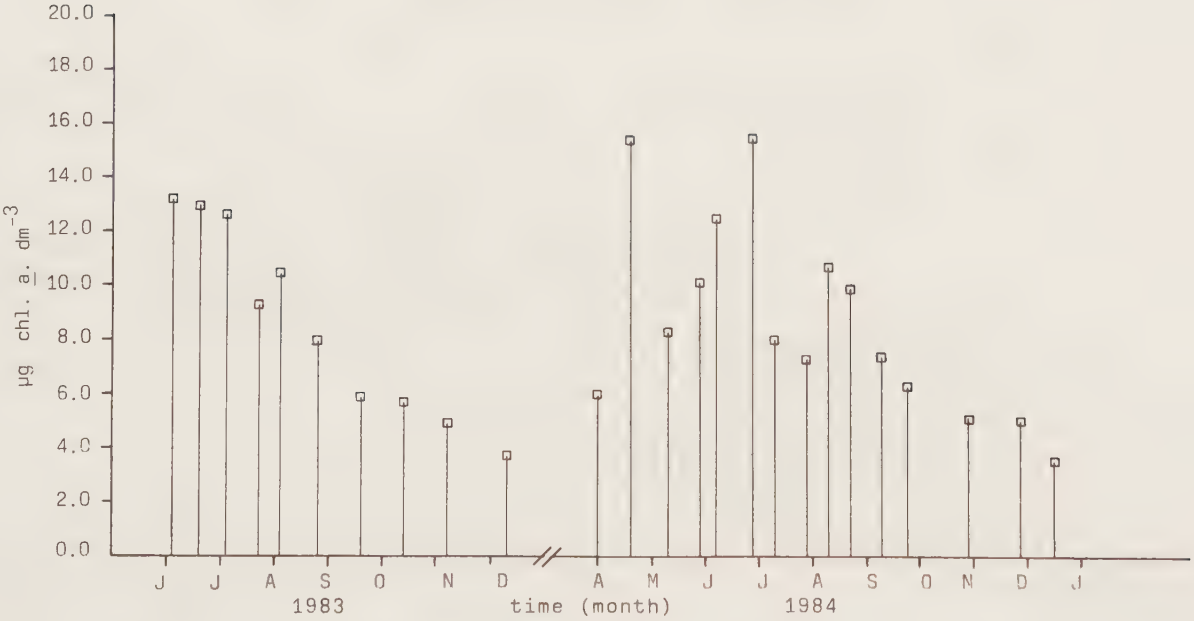

Fig. 15 - Integrated mean values for chl. a. Results represent mean values from samples collected at three stations at different depths.

slight decrease of chl. a concentrations in the first half of August, chl. a values rise clearly again in the second half of this month. Thereafter chl. a content decreased drastically by September in both years, and this trend went so until the end of the year, where the lowest chl. a values were estimated.

The primary production per unit area (mg $C.m^{-3}.h^{-1}$) is dependent upon the amount of light reaching the surface on a given time, on the amount of non-phytoplankton materials causing light extinction in the water column, on size and physiological state of phytoplankton populations and the availability of inorganic nutrients.

Because of the uncertainties in extrapollating the production values for the incubation time to a daily production figure, the results have been expressed here in terms of mg $C.m^{-3}.h^{-1}$ (Fig. 16a, 16b, 16c and 16d) together with the values for extracellular carbon release in percent. The nutrient concentration in the Bostal Reservoir waters, with the exception of P-compounds, never reached production limiting concentrations, which is likely to be the main reason for the relatively high production measured during the study.

Just after the ice-breaking, with the availability of nutrients, light and increasing temperatures, the primary production rates tend to increase, as it normally occurs in the temperate regions waters. During the spring mixing, integrated primary production rates were interme-

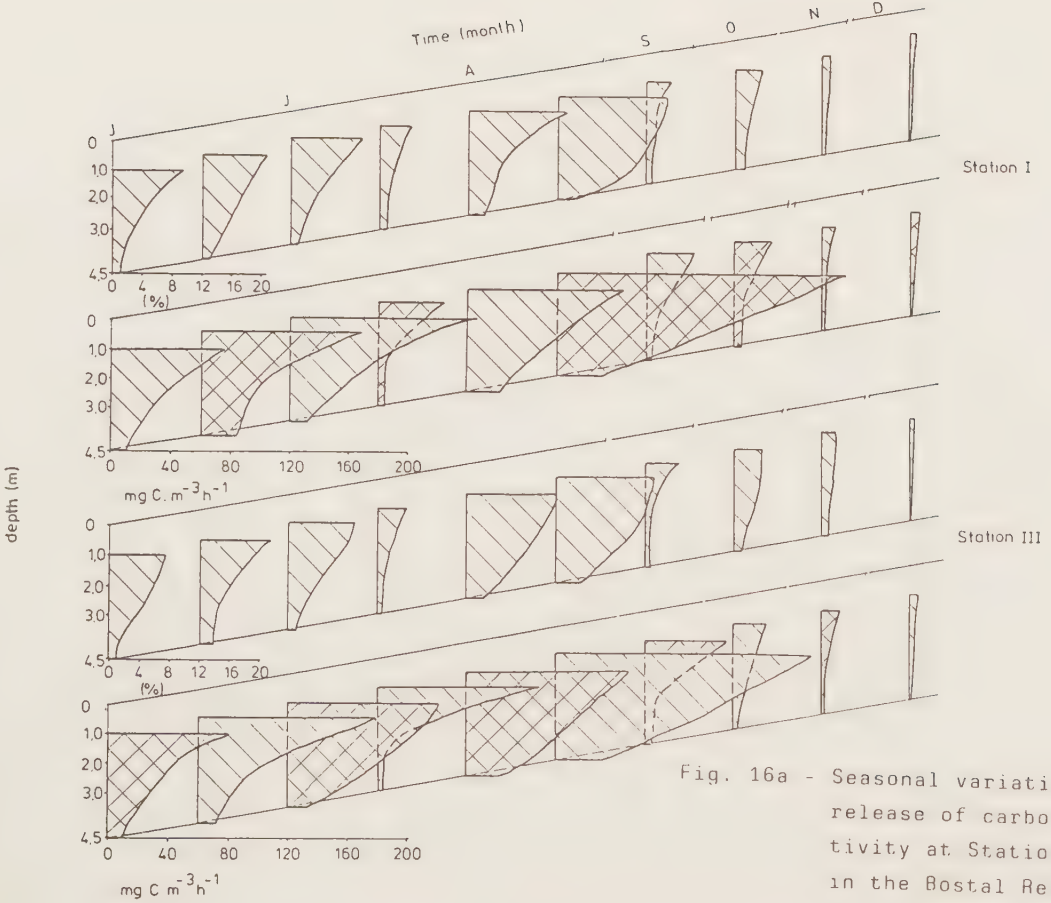

Fig. 16a - Seasonal variation of extracellular release of carbon and primary prodoc-tivity at Station I and Station III in the Bostal Reservoir for the year 1983.

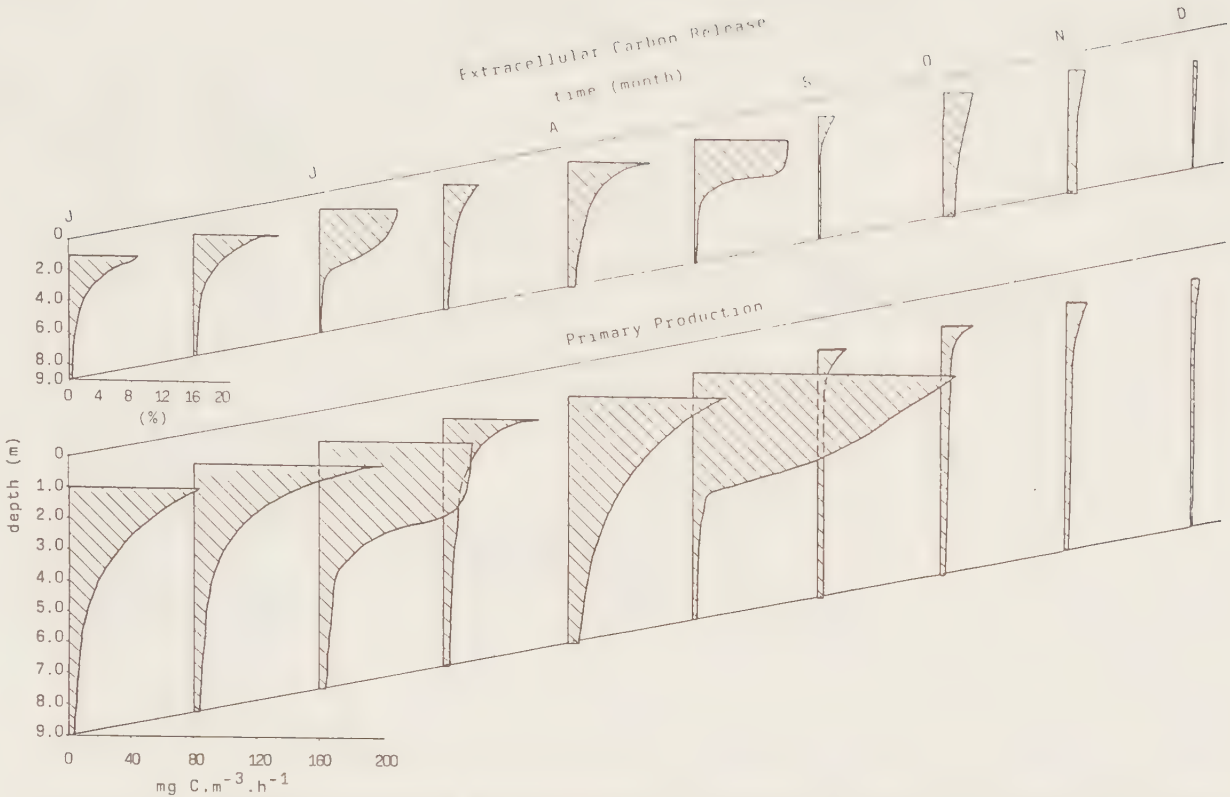

Fig. 16b - Seasonal variation of extracellular release of carbon and primary productivity at Station II in the Bostal Reservoir for the year 1983.

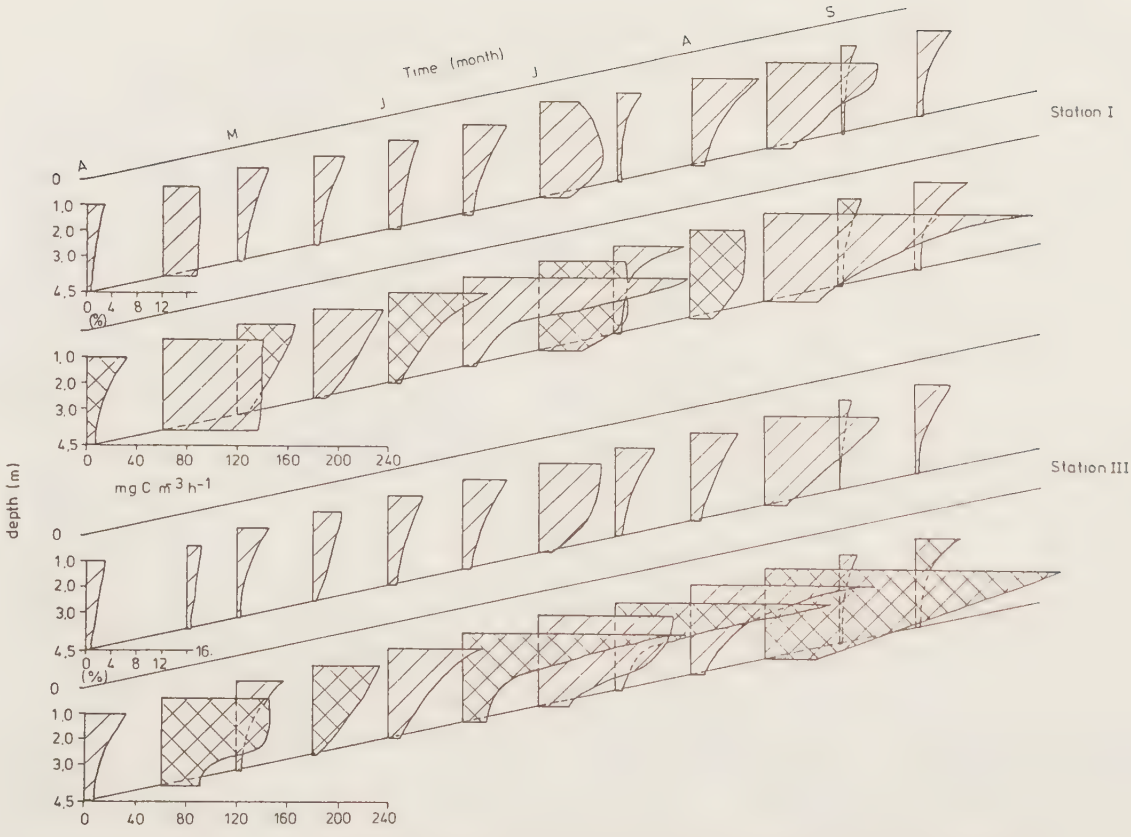

Fig. 16c - Seasonal variation of extracellular release of carbon and primary productivity at Station I and Station III in the Bostal Reservoir for the year 1984.

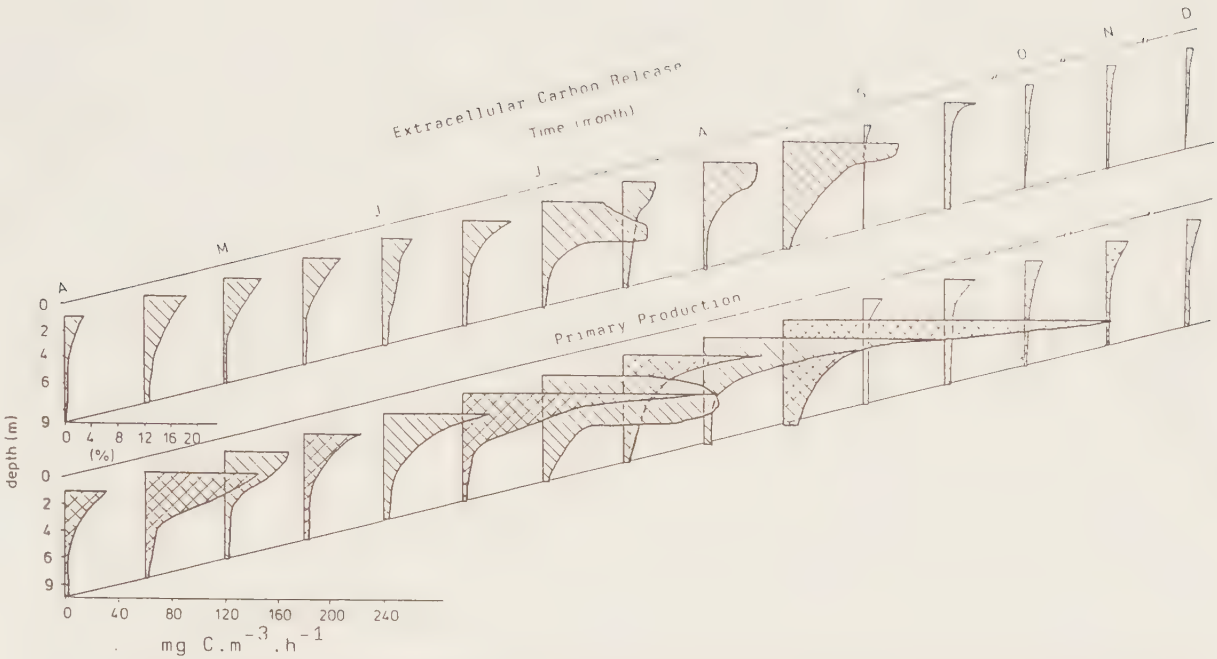

Fig. 16d - Seasonal variation of extracellular release of carbon and primary productivity at Station II in the Bostal Reservoir for the year 1984.

diate between production of the period autumn-winter and production of the stratification period. However, in absolute terms a very high integrated primary production rate was measured in 17 April 1984 (42.18 mg $C.m^{-3}.h^{-1}$). The primary production rates rose shortly after the onset of the stratification in both 1983 and 1984. The production values were highest during the time of highest solar radiation, i.e. July and August, resulting in an extremely value of 248.58 mg $C.m^{-3}.h^{-1}$ at the depth of 1.0 m in August 1984. It is remarkable that at that time a production of 33.06 mg $C.m^{-3}.h^{-1}$ could still be recorded at a depth of 5.0 m, though the 10 percent light depth was already at 2.50 m. In both 1983 and 1984, primary production rates climbed until late August, after which they declined precipitously. In both years the photosynthesis rates continued to decline thereafter, showing their minimum in December, where 2.44 and 4.35 mg $C.m^{-3}.h^{-1}$ for 1983 and 1984 respectively, were measured.

While taking up carbon in order to perform photosynthesis, phytoplankton cells release considerable amounts of organic substance to the surroundings, i.e. glycollic acid, aminoacids, peptides, organic phosphates etc. (Hellebust, 1965; Fogg, 1971; Al-Hasan, 1976). In this work the amount of ^{14}C measured in the filtrates varied from 0.10-18.12 percent of the total carbon fixed.$m^{-3}.h^{-1}$ (Fig. 16a, 16b, 16c and 16d). The highest percentages of released carbon (10-18 percent) were observed in the summer months of the years investigated. The highest concen-

tration of carbon lost to the environment was 42.72 mg $C.m^{-3}.h^{-1}$. The release of large percentages of the fixed carbon did not occur during the period autumn-winter.

The concentration of total phosphorus and total nitrogen of interstitial waters in the study area at three stations are shown in Fig. 17 and 18 respectively. Values either for total P and total N were always high by comparison with the overlying water.

The average total P values varied between 10.09 and 71.74 µg at $P.dm^{-3}$. The ratio between the average interstitial water total P concentrations and the yearly average of total P concentrations at 16 m ranged between 6.30 and 12.15.

Values for the total N found in the interstitial waters varied between 71.04 and 768.62 µg at $N.dm^{-3}$. The ratio total N in the interstitial waters:total N in the overlying water varied between 1.20 and 20.68.

The relationships between variables were examined by means of linear regression analysis.

The values for integrated primary production to the whole reservoir were positively significantly correlated with the values for integrated chl. a ($r=0.76$, $n=25$, $p<0.001$) (See Fig. 19). Chl. a integrated values were also linearly correlated with Secchi disc depth, however negatively ($r=-59$, $n=25$, $p<0.01$) (Fig. 20 and 21). The correlation coefficient between solar radiation* and integrated prima-

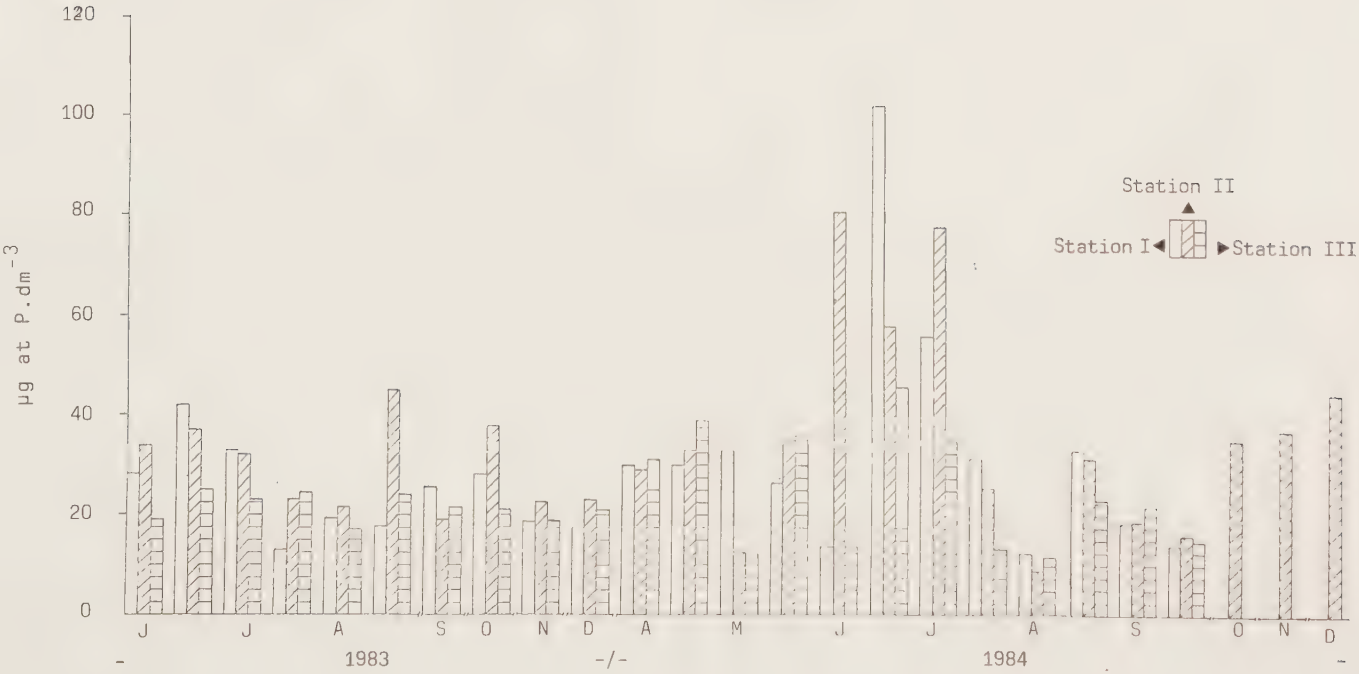

Fig. 17 - Seasonal variation of total phosphorus in the interstitial water of the Bostal Reservoir ih the years 1983 and 1984.

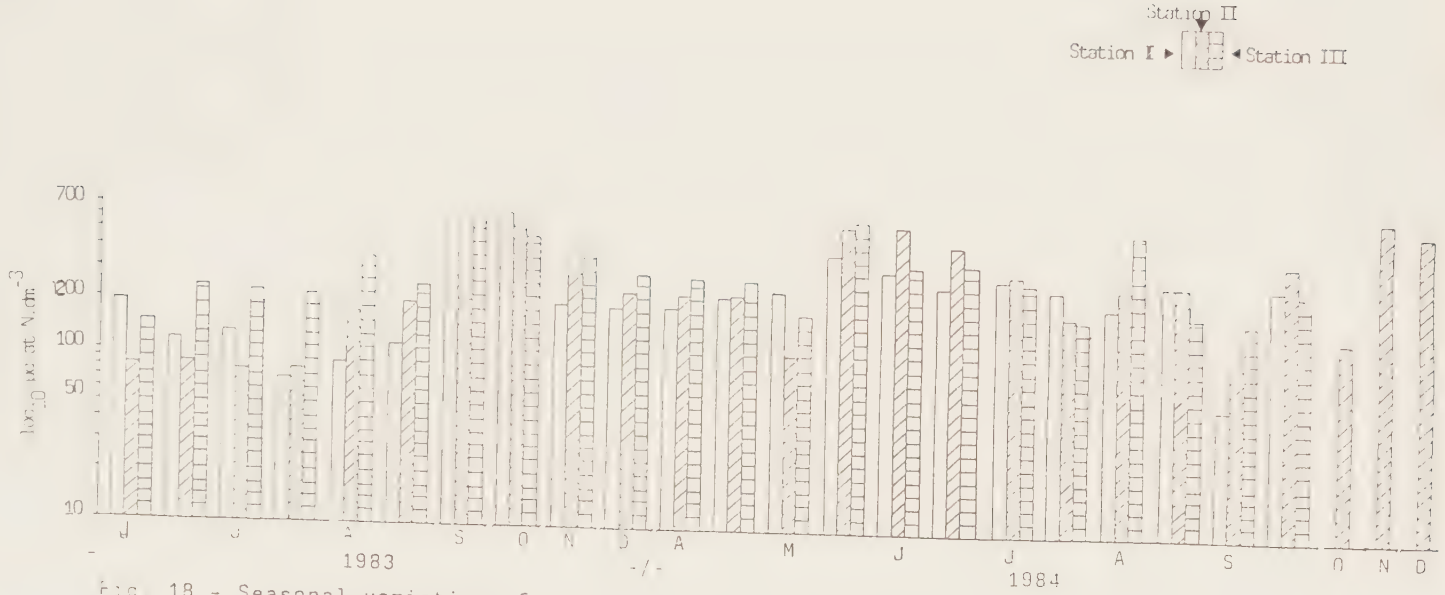

Fig. 18 - Seasonal variation of total nitrogen in the interstitial water of the Bostal Reservoir in the years 1983 and 1984.

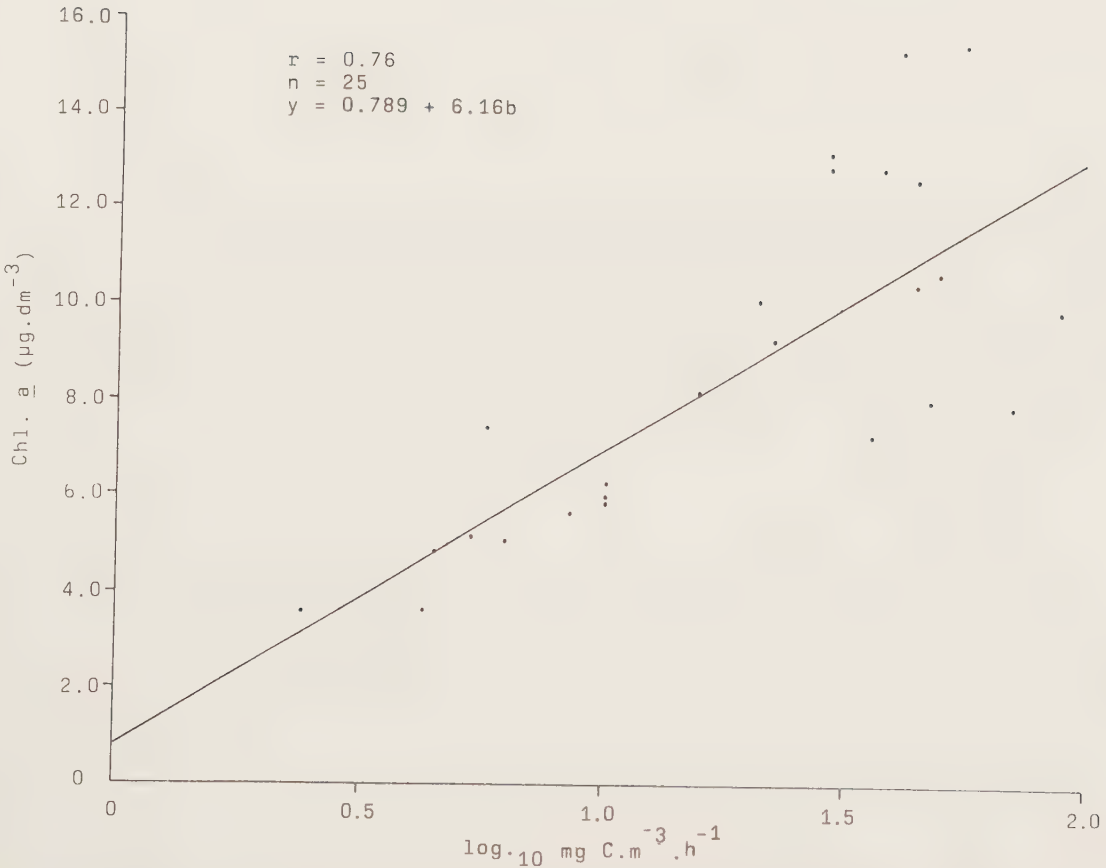

Fig. 19 - Linear regression analysis of primary production rates and chl. a concentrations.

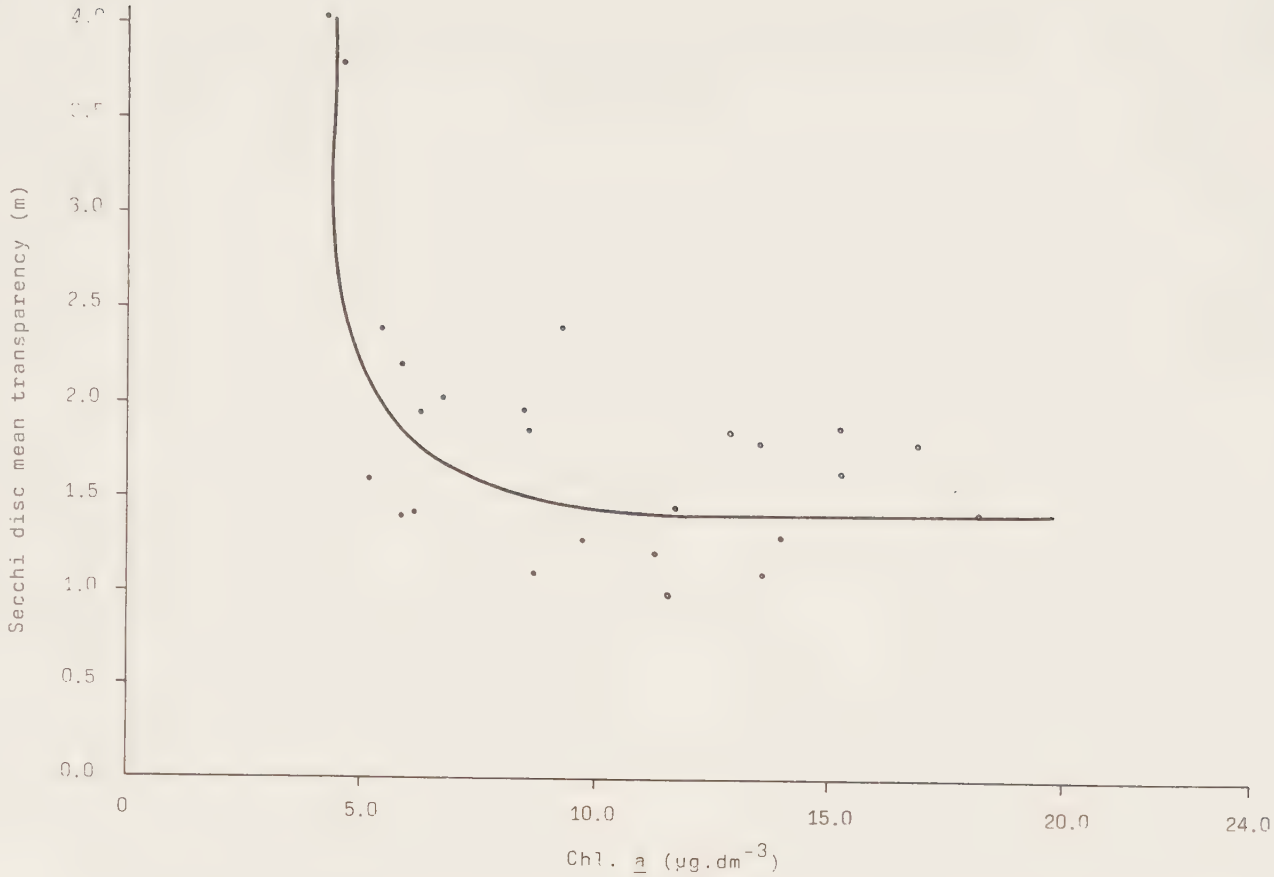

Fig. 20 - Relationship between mean chl. a and Secchi disc mean transparency for the Bostal Reservoir - June 1983 to December 1984.

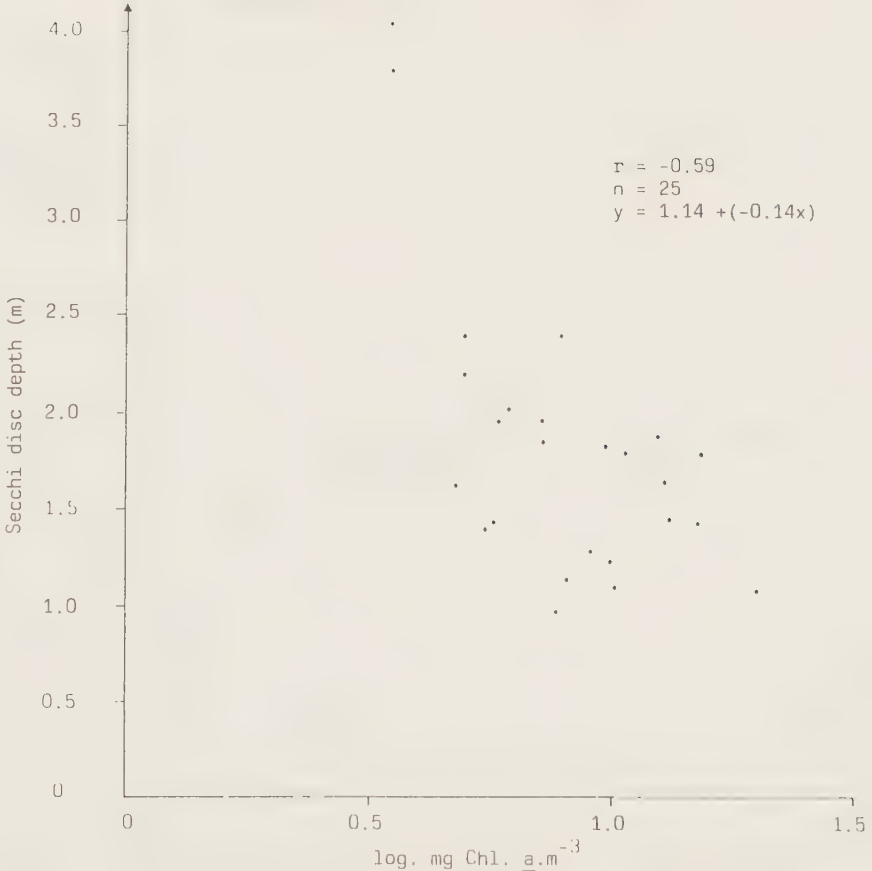

Fig. 21 - Relationship between mean chl. a and Secchi disc mean transparency for the Bostal Reservoir - 1983 and 1984.

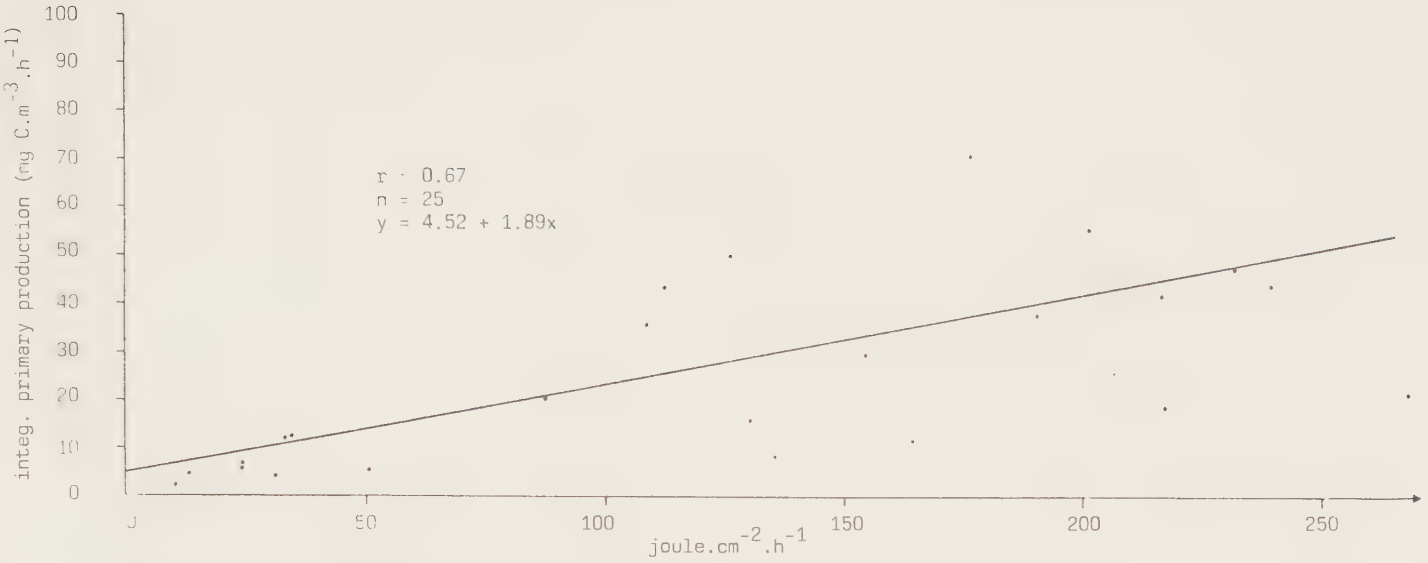

Fig. 22 - Linear regression analysis between solar radiation and integrated primary production rates.

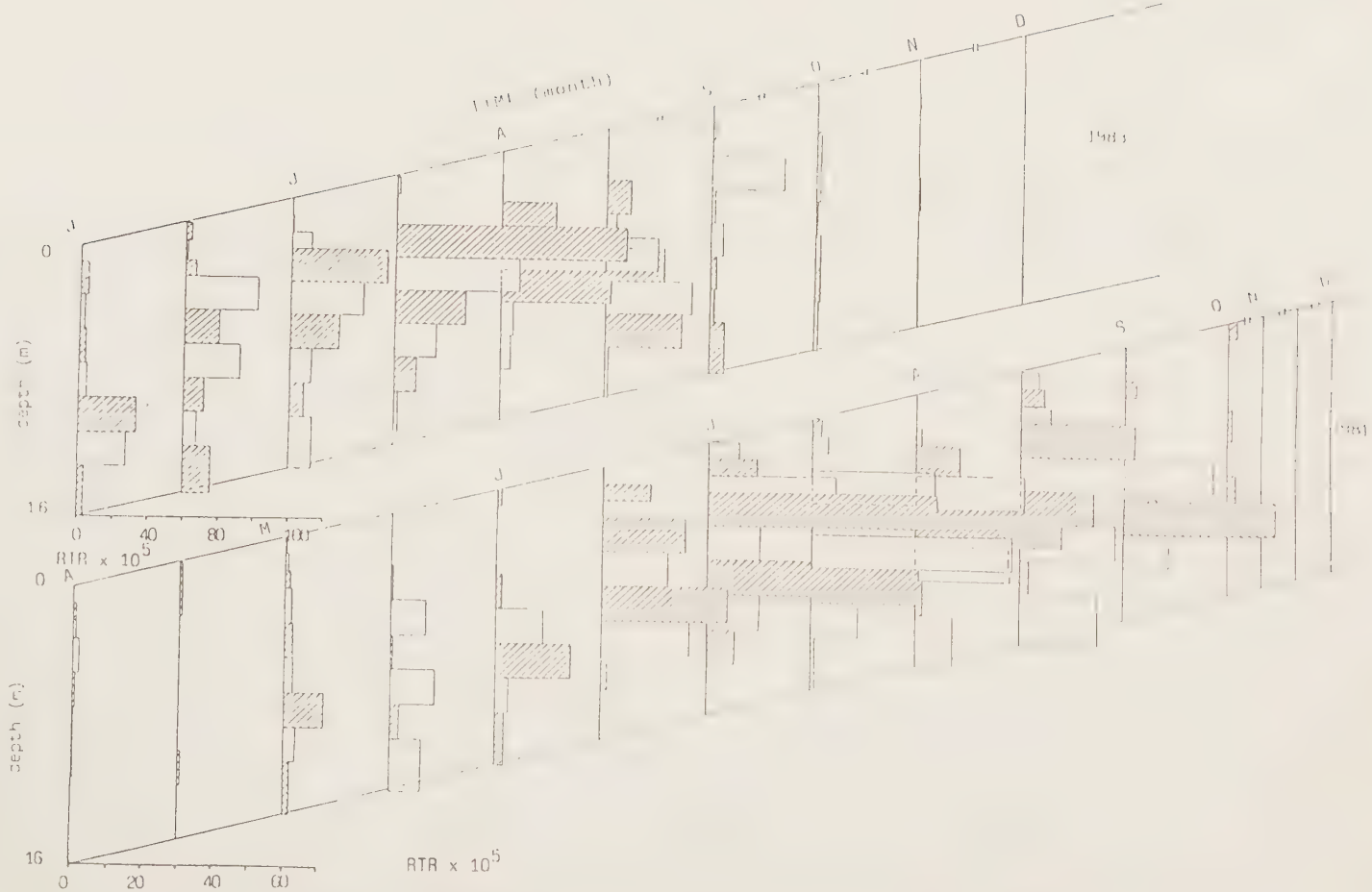

Fig. 23 - Relative thermal resistance for the Bostal Reservoir in the years 1983 and 1984.

ry production rates was calculated, and a significantly correlation was found ($r = 0.67$, $n=25$, $p<0.001$) (Fig. 22).

*In order to obtain an hourly mean for solar radiation, the following procedure was utilized: a mean from the solar radiation values from 10 00 h to 17 00 h was obtained (time interval where the incubations have taken place). Solar radiation data were kindly provided by the Meteorological Office-Ensheim Airport, Saarbrücken.

DISCUSSION AND CONCLUSIONS

One cannot deny the importance of morphometric parameters when interpreting biotic relationships in freshwater ecosystems, and the fact that such parameters are interrelated. However, due to a combination of incompletely understood geological, geographical, and local forces, any lake differs considerably from the statistical relations derived from local groups of lakes (Straskraba, 1980).

As far as morphometric measurements are concerned the Bostal Reservoir would be classified as not very deep reservoir (relative depth 1.38 percent). The consequence is that the Bostal Reservoir due to its small relative depth is more likely to be influenced by winds than other water bodies which show a relative depth of 4 percent, for instance. This reflects the long circulation of the Bostal waters in the spring and the relatively short stratification in the summer. Its shoreline depelopment indicates an approximately elliptical form thus showing a large surface and low depth. In comparison the $\bar{z}:z_{max}$ (mean depth : maximal depth) ratio indicates the form of the basin in terms of volume development (Wetzel, 1983). The Bostal Reservoir has a $\bar{z}:z_{max}$ of 0.38, which is a value that would be giving by an approximately conical depression. Indeed, the development of volume (D_v) of the Bostal Reservoir was 1.18, indicating, therefore, its conical shape.

Thermal stratification, which contributes so much to lake structure, is a direct result of heating by the sun,

It is evident that the relatively high photosynthetic rates measured in the Bostal Reservoir in the euphotic region, especially during periods of high solar radiation intensities, led to oxygen concentrations just under saturation or even oversaturated. A small depression of surface oxygen concentration occurred in September 1984. This was probably caused by the thickening of the mixing layer and incorporation of deeper, anoxic water with surface water. This phenomenon was not detected in September 1983, possibly due to the large interval between the two sampling periods. In deep water of the Bostal Reservoir dissolved oxygen concentrations remained unsaturated throughout the year. In April 1984, however, deep water also became nearly saturated as a result of the water mixing, and high oxygen concentrations of the winter. As a result of the aerobic decomposition of organic matter after the Asterionella formosa bloom dies out, the oxygen concentations in deep water begin to fall.

The duration and intensity of the oxygen depletion in deep waters was directly linked to the amount of organic matter reaching the hypolimnion. The depletion of oxygen in deep water during summer stratification was associated with the appearance of H_2S. As the deep water was collected one could smell its characteristic odour.

Towards November and December oxygen concentrations were again very high, and very near to the saturation point, indicating that during the winter ice cover period any possible oxygen deficit did not originate from the former pe-

and rather than any absolute temperature, is the most important in water bodies (Goldman & Horne, 1983). In May, some clear evidence of stratification could be seen in the Bostal Reservoir as the water body exceeded 11 °C, and a thermal gradient began to develop in the upper layers generating a weak thermocline at a depth varying from 3 to 7 m. This thermal gradient, ranging from 2.2 to 3.4 °C between the upper and lower layer, already constitutes a barrier for any mixing-up. Already by the first half of June in both years thermal layering had become very pronounced. The upper water column reached 13 °C by the first half of June, and the thickness of upper mixed layer at this time was 7 m. Though the continuous warmth a steady stratification developed, and both in 1983 and 1984 the upper water column continued to take up heat well after the establishment of the stratification. In 1983 the reservoir reached maximum heat content in the second half of July, when the temperature of the epilimnion rose to 24 °C, and the difference between the epilimnion and the hypolimnion was 13 °C. On the other hand, in 1984 the temperature rose more slowly, producing maximum epilimnetic temperature in the third week of August. As a whole 1983 epilimnetic temperatures were higher than those of 1984. However, the 1984 maximum hypolimnetic temperature was essentially the same as that in 1983. During the stratification time the thermal gradient was about 0.53-0.88 $°C.m^{-1}$. In 1983 cooling of the upper water column began in the first week of August, while in 1984 it commenced just in the last

week of this month. Cooling of the epilimnion reduced the stability of stratification sufficiently to allow gradual degradation of the thermocline by late September. The stratification season ended with complete mixing during the second half of September in both years. By the time complete mixing occurred, the reservoir temperatures had already dropped to 13 °C.

The Bostal Reservoir behaves to some extent like a dimictic lake, with two distinct periods of circulation (spring and autumn) and two periods of stratification (winter and summer). In both 1983 and 1984, an ice cover formed on the Bostal Reservoir in late December or early January. In both years, the ice broke up several times until it was not longer formed again in late February, early March. The complete turnover down to 16.0 m occurred between October and December. In winter after the water has been covered with ice a stratification situation occurred, where the colder water lies over the warmer water. In spring there was another turnover and the water circulates again. Due to its lack of protection from the wind in combination with its relatively small size and low relative depth (1.38), the duration of this mixing period can be of several weeks. Mid-May marks the beginning of the stratification period.

Dissolved oxygen is a very important component of freshwater, and its depletion has a great significance to organisms and to the concentration of many inorganic nutrients, as oxygen affects their solubility.

riod.

Although oxygen concentrations in the bottom half of the water column were quite low during the stratification, this alone does not appear to be linked with the trophic state of the reservoir. Perhaps of much more significance would be the vertical extent over which oxygen depletion occurs and its relation to the total volume of the reservoir.

The rate of oxygen depletion from the hypolimnion during summer stratification increases not only with depth, but with time during the stratification period (Wetzel, 1983). We calculated during the summer stagnation of 1983 and 1984 the areal hypolimnetic oxygen deficit (AHOD) of the Bostal Reservoir (See Table V). This is the average amount of oxygen in the hypolimnion per unit surface of hypolimnion as computed by integration of the oxygen concentration with the depth from the top of the hypolimnion to the reservoir bottom at the beginning of the stratification. In 1983 the AHOD was 215 $mg.m^{-2}.day^{-1}$ and in 1984 it was 338 $mg.m^{-2}.day^{-1}$, similarly Burns (1976) reported mean values between 380 and 613 for Lake Erie, and Lasenby (1975) published results between 270 and 410 $mg.m^{-2}.day^{-1}$ for 7 mesotrophic lakes. These values are no different from the those presented here for the Bostal Reservoir.

It is interesting to note that in the first year studied temperatures were found to be higher as a whole than in 1984, however the stratification period was shorter in

Table V

Areal hypolimnetic oxygen deficits in 1983 and 1984 for the Bostal Reservoir

STRATA (m)	VOLUME (m^3)	Oxygen Concentrations ($mg.dm^{-3}$) 3 June 1983	25 August 1983	total Oxygen (metric ton) in Strata 3 June 1983	25 August 1983
9 - 11	7.0×10^5	6.7	0.0	4.69	0.0
11 -13	4.0×10^5	4.9	0.0	1.96	0.0
13 -16	2.54×10^5	4.8	0.0	1.21	0.0
			T o t a l	7.86	0.0
				AHOD = 215 $mg.m^{-2}.day^{-1}$	
		7 June 1984	23 August 1984	7 June 1984	23 August 1984
9 - 11	7.0×10^5	9.15	0.05	6.405	0.035
11 -13	4.0×10^5	8.10	0.0	3.24	0.0
13 -16	2.54×10^5	7.40	0.0	1.87	0.0
			T o t a l	11.52	0.035
				AHOD = 338 $mg.m^{-2}.day^{-1}$	

the latter year, as well as the AHOD, which was smaller in 1983 than in 1984.

Other factors than temperature are most likely to play an important role on the duration of the summer stratification in the Bostal waters, such as its low relative depth, which allows the influence of wind on the water body, and the thickness of the hypolimnion.

The areal hypolimnetic oxygen deficit bears a relationship with several lake parameters, that are used in the trophic status classification of a water body, such as Secchi depth, total phosphorus concentration, annual primary production etc. (Lasenby, 1975; Cornett & Rigler,1979, 1980). AHOD alone is not itself a good indicator of productivity or even for classifying lakes into trophic categories as proposed by Hutchinson (1957), unless a factor is included to compensate for the thickness of the hypolimnion (Cornett & Rigler, 1979). In reservoirs, consideration of water drawdown is to be taken when applying AHOD to classify such water bodies into trophic categories, as it alters, the thickness of the hypolimnion.

The chl. a content is taken by the planktologist as an indication of phytoplankton biomass and as an important factor in the determination of photosyntheitic activity (Steeman-Nielsen, 1961). Over the period covered in this study, the highest chl. a concentrations were observed during the seasonal blooms of phytoplankton. The spring bloom of Asterionella formosa produced the highest chl. a values as already demonstrated by Kaltwasser & Zaiss (1980).

With regard to the depth distribution of chl. a it can be seen that the results from the three sampled stations at the euphotic zone are very similar, indicating identical water masses as one would expect from the reservoir size.

The higher chl. a values for the near surface level throughtout the year are generally the result of increased solar radiation and its duration combined with sufficient nutrient availability. As far as solar radiation is concerned, however, it might also have a negative effect on the phytoplankton populations. In the first sampling of July 1984 (10 July), for instance, deeper layers showed chl. a values higher than surface level ones (mean solar radiation = 231.5 Joule.cm^{-2}.h^{-1}), and the sunshine duration at that day was 12 hrs 18 min. That is, the high light intensities have inhibited the phytoplankton populations living at surface levels, and results for primary productivity confirm this statement.

A trophic state index for lakes based upon the transparency of the water measured by the Secchi disc has been proposed by Carlson (1977). The index is computed with an equation in with the Secchi depth measured is a power function of chlorophyll concentrations and therefore of algal population densities. In fact, the transparency of water meassured by the Secchi disc is affected by two factors: (i) the extinction of light by dissolved or particulate matter in the water, and (ii) the extinction of light by chlorophyll. If we call the extinction coefficient (non-

chlorophyll light absorption) and assume that the Secchi disc depth measured can be approximated by the depth of 20 surface light (Lorenzen, 1978), the Secchi disc depth (Z_{sd}) can be expressed as:

$$Z_{sd} = \frac{-\ln (0.20)}{\alpha + \beta \text{ Chl.}}$$

where α represents the light extinction and β Chl. the chl. a concentration. It is in nature, however, very difficult to separate those two factors. Lorenzen (1980) postulated that using data for chl. a and Secchi disc, as used by Carlson (1977), from different lakes to build models, can result in very misleading situations, and suggested that the value of the light extiction (α) should be obtained for any particular lake under study, as lakes with different colour and turbidity show different light extinction values.

Fig. 20 and 21 show the relationship between Secchi disc mean transparency and mean chl. a measured at three stations in the euphotic zone for the Bostal Reservoir. The fact that there is a relationship between Secchi disc depth and chl. a values should be interpreted with caution since other factors can affect the Secchi disc transparency values, as already mentioned. The relationship occurs only because a plankton population with a large number of cells and colonies tend to have more chlorophyll than a very small population. Even though it is not recommended, as we have seen, to extrapollate Secchi disc transparency measurements into trophic status classification, the Secchi disc values

remain important and significant for the limnological research. It is clear that anything that affects turbidity will affect the transparency, and such easily obtainable infromation as the Secchi disc transparency, in long term, could be used as indicator of changes in the abundance of phytoplankton, when production rates data could not have been generated.

Generally speaking primary production is related to biomass, and seasonal cycles of phytoplankton have a similar form, to some extent, to those of primary production. However, rethinking this concept may help to understand the dynamics of phytoplankton and primary production. Rates of primary production reflect the interaction of several factors: weather conditions, circulation patterns, turbidity, grazing, and, in addition, the physiological state of phytoplankton cells. The result of this is the biomass itself. However, production as reflected in biomass can vary with time. The production per unit chl. a for this study, ranged from 0.67 to 9.02 mg C fixed.mg Chl. $a.h^{-1}$. Fogg (1980) gives an average value of 3.7 mg C fixed.mg Chl. $a.h^{-1}$ as an approximation for the assimilation rates of carbon, which is in good agreement with the results found here. The highest ratio was found in August, which means that during this time phytoplankton cells were producing more energy per biomass than in any other period.

Production per unit chlrophyll per hour is affected principally by the physiological condition of the phytoplankton and by temperature (Taguchi, 1976; Harris, 1978).

Another piece of information concerning the phytoplankton is the turnover time, that is, the time the phytoplankton cells take to double their biomass. At present, there is no reliable or widely accepted method for determining the carbon content of phytoplankton (Redalje & Laws, 1981). Strickland (1965) used a factor of 30 to convert chl. *a* measurements into phytoplankton carbon. This factor may very depending upon the physiological state of the phytoplankton (Antia *et al.*, 1963). Indeed, Watson (1978) reported that in local Woods Hole waters the C:chl. *a* ratio was around 30 during winter months when light intensity was low, in summer months, however, this ratio may nearly rise to 100. Zaiss (1981) calculated the average turnover time for the algae of the Bostal Reservoir to be 5.8 days. Schindler & Holmgren (1971) calculated turnover times for the phytoplankton of several shallow and weakly stratified lakes in the Canadian Precambrian Shield. Values obtained by these authors ranged from 0.44 to 2.77 days; they stated that such values seem to be unrelated to light, nutrient or lake type, and that other factors, including grazing might play a major role in relation to turnover time.

It seems likely that errors involved in the estimation of turnover time due to the carbon content conversion are very common as the authors already mentioned used different conversion values. Therefore, in this investigation we decided not to give information on the phytoplankton turnover time on the basis of such uncertain information.

The highest primary production rates (maximal rate = 248.58 mg $C.m^{-3}.h^{-1}$) were measured in August in both years, thus confirming the results of Kaltwasser & Zaiss (1980). In view of the constant supply of relatively nutrient-rich water originating from the two brooks: Dämelbach and Bos, that form the Bostal Reservoir, and the Bostal Reservoir average depth (6.3 m) (Zaiss, 1984), together with the availability of nutrients, it is not surprising such high rates.

Wright (1967) postulated that water bodies with surface outflow tend to trap nutrients, while those with deep outflow dissipate nutrients. In the Bostal Reservoir there are a surface and a deep outflow. However, during summer months due to a negative water balance, deep anaerobic water is not normally released, thus trapping nutrients that are released from the bottom sediments.

The primary production data for the Bostal Reservoir indicate that there is marked similarity in production between years. During high phytoplankton standing crop periods, primary production rates were also high, occuring the opposite in times where phytoplankton standing crop was at its lowest. Therefore, the very good relationship between chl.a and primary production rates found, was to be expected.

The release of extracellular products of photosynthesis has been measured in this investigation. The release of large percentages of the fixed carbon in the summer was expected as the maximum solar radiation and maximal primary

production rates are found in that time. High light intensities can cause increased release of phytoplankton carbon through photooxidation damage to cells and photoinhibition of the photosynthetic systems (Fogg et al., 1965; Hellebust, 1965).

The positive relationship between mean percentage of carbon released at 1 m for the three stations and mean hourly solar radiation indicates that the solar radiation may be likely play a major role in the release of cellular carbon into the surrounding waters. When natural samples were incubated at high light intensities, 1 to 38 percent of the carbon fixed was released into the medium (Horne et al., 1969). However, the results found in this work showed a much more conservative rate of release. They rarely exceeded 15 and rates were generally below 6 percent of the total carbon fixed. Light may either enhance photosynthesis or limit the process, depending upon the intensity (Yentsch & Scagel, 1958). It seems evident that light is a relevant factor on the release of cellular carbon and it may also be hypothesised here that diel variations of light might influence daily release of cellular carbon. However, this point is outwith the scope of this investigation.

Arthur & Rigler (1967) pointed out that labelled organic matter found in filtrates of plankton samples may be released by cell breakage during filtration. In this investigation a very low pressure was always applied when samples were filtered in order to minimize this error.

The results of this study confirm the recommendations of other authors (Fogg, 1971; Sellner et al., 1976) that assessing primary production with the radiocarbon technique, without taking into account the released radiactive carbon, can undoubtely lead to underestimation of the primary production.

The mineral requirements of phytoplankton are very similar to those of other plant cells. In addition to carbon, hydrogen and oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, copper, zinc, manganese, molybdenun, cobalt and chlorine are essential. In any particular aquatic ecosystem any or more of these elements may be in short supply. However, the concentration of any nutrient in the external medium is not alone a sign that such nutrient limits the phytoplankton growth rate. Algal cells, in general, may accumulate nutrients that are sufficient to carry them through successive divisions. Asterionella formosa, for example, is capable of storing in this way reserves that support nearly seven doublings (Fogg, 1980). Although a correlation between concentration of a nutrient in an aquatic ecosystem at a particular time and phytoplankton growth at same time is not usually found,this aspect has an enormous importance in the establishment of algal communities. The ability to utilize and to store nutrients at low concentrations may favour some phytoplankton that are able to carry this, and therefore outcompete other cells, changing, therefore, the phytoplankton species composition.

Estimates of the nitrogen available for the reproduction and growth of microorganisms have usually included measurements of only the inorganic fractions present as ammonium, nitrate and nitrite. Recent studies of the abilities of phytoplankton to take up and utilize dissolved organic nitrogen compounds reveal that in some situations phytoplankters may even taken up dissolved organic nitrogen (DON) in preference to inorganic forms such as nitrate or nitrite (McCarthy et al., 1977; Butler et al., 1979; Antlia et al., 1980).

The distribution of ammonium in freshwater varies seasonally and spatially within lakes and depends upon the productivity of the water body, and the extent of allochtonous or autochtonous organic matter (Wetzel, 1983). This has been observed in the Bostal Reservoir waters. Under anaerobic conditions ammonium accumulated in the hypolimnion as a result of the nitrogen release from the reservoir sediments. As ammonium concentrations increased, the nitrate in the deep layers decreased. The nitrification of NH_4^+ to NO_2^- and NO_3^- is redox dependent, therefore, under anoxic hypolimnetic conditions NO_3^- disappears; as a consequence of the non-oxidation of ammonium.

The process of ammonification occurred with more intensity as stratification progressed throughout the summer. This is consistent with summertime increases in ammonium flux across the sediment water interface (Boynton, 1980). Numerous authors have reported that the numbers of ammoni-

fying bacteria in the water and in bottom sediments attain their maximum at that time, and that low temperature does not seem to inhibit their biochemical activity (Braune & Uhlemann, 1968; Ritter et al., 1971). Niewolak (1975) estimated the maximal numbers of ammonifying bacteria in waters of fertilized lakes at the Wegorzewo region (Poland) to be 1.06×10^6 cells in 1 cc of sample. The total number of bacterial cells that were estimated using the acridine orange direct count technique for the Bostal Reservoir at 16.0 m was 6.25×10^6 for 3 August 1983 and 25 August 1983 as well (da Silva, unpublished data). At these times ammonium was released at its maximum from sediments, indicating the importance of bacteria for the occurence of such phenomena.

Austin & Lee (1973) investigated two lakes in Wisconsin (USA) (Lake Mendota, hard-water and eutrophic and Trout Lake, a soft-water and mesotrophic-oligotrophic lake). They found that under aerobic or anaerobic conditions Trout Lake released considerably less inorganic nitrogen than did Lake Mendota, although in the former higher concentrations of available nitrogen could be estimated. The authors noted that Lake Mendota provided a more optimum environment for the bacteria that caused the solubilization and nitrification reactions. Bostal Reservoir sediments appears to provide an optimum environment for the bacteria, as far as nitrogen is concerned, as the sediments of the reservoir were soils from land which had been intensively cultivated before the damming, and still present high amounts of ni-

trogen.

Temporal patterns of nitrate concentration in the Bostal reservoir waters were also discerned. Concentrations of NO_3^- generally decreased with depth during summer and were lower than those in the spring at all depths, suggesting reduced nitrification rates.

The total organic nitrogen was the main component among the different forms of nitrogen in the Bostal Reservoir. Wetzel (1983) stated that, the dissolved organic nitrogen of freshwaters may constitute over 50 percent of the total soluble nitrogen. Sources of dissolved organic nitrogen in freshwater ecosystems include excretion or leakage from phytoplankton (peptides and aminoacids) (Gocke, 1970; Walsby, 1974; Steinberg, 1977), zooplankton excrete urea active in the medium, and urea is decomposed biologically in natural waters and represents an alternative source of nitrogen for N-starving cells (Carpenter et al., 1972; McCarthy, 1972; da Silva, 1985). It seems that this fraction of nitrogen closed followed the dynamics of biomass of the phytoplankton, as maximal concentrations were found in the summer, and minimal during the winter. Urea as the dissolved organic nitrogen is transformed bacteriologically into ammonia. Its concentration in waters can be augmented by sewage effluents in the vicinity or human activities. The Bostal Reservoir receives ca. 10000 visitors on sunny weekends in the summer, and these also contribute significantly to the total-N pool.

It has been established that phosphorus is, on average, the major limiting factor in freshwater ecosystems, and that any extra load of phosphorus into the system may lead to increase in phytoplankton abundance. On the other hand, nitrogen seems to be more important as a growth limiting factor in waters already eutrophicated (Forsberg, 1977). In this investigation phosphorus and nitrogen were studied in detail in order to furnish a picture of the trophic state of the Bostal Reservoir.

In the year 1983 no massive release of phosphorus was observed from the sediments, in spite of the anoxic conditions that prevailed in the hypolimnion from early August until the middle September. Results from 1984 depicted just the opposite, where just after the beginning of O_2 depletion in the deep waters of the Bostal Reservoir an increase of the phosphorus fractions was observed. This trend continued until just after the end of the stratification. Zaiss (1981) stated that most of the phosphate in sediments of the Bostal Reservoir is bound as iron-phosphate. Consequently, the phosphorus dynamics in the Bostal sediment-water interface could be governed mainly by redox fluctuations. The two brooks that form the reservoir bring large amounts of iron into the water body (Kaltwasser & Zaiss, 1980).This is no surprise, as geologically the Bostal Reservoir catchment area belongs to the iron-rich Permian red beds.

This study has provided data on the areal hypolimnetic oxygen deficits of the Bostal Reservoir. Values of 215 and 338 $mg.m^{-2}.day^{-1}$ were estimated, respectively, for

1983 and 1984. In addition, the stratification process in 1984 occupied a longer period of time than in 1983, namely from May until late September, and an anoxic hypolimnion was present from 10 July until the end of September. In 1979 the anoxic hypolimnion remained from June until October (Zaiss, 1981). Therefore, it is likely that the short duration of O_2-depletion in the hypolimnion in 1983 was the main reason for the non-release of phosphorus in the water from the sediments. In the Bostal Reservoir the ground water can be drained away, thus eliminating, in the summer, high amounts of phosphorus and nitrogen, together with very poorly oxygenated waters. This operation is very irregular, and it is reasonable to suppose that more frequent draining would affect the phosphorus concentration in the deep waters. There are no records of such operations for the Bostal Reservoir, however we may suppose that these operations were carried out more frequent in 1983 than in 1984, as in the former year a higher precipitation occured in the first six months of the year compared to 1984.

The results for the year 1984, are, however, much clearer. As the hypolimnion became anaerobic the rate of phsophorus exchange between the sediment and the surrounding water increased.

As a whole, total P concentrations in the interstitial waters varied considerably during the period studied, especially in 1984. The stations sampled were marked with a fixed buoy, and the boat used in sampling was tied up to

the buoy cable. It is believed that due to the windy conditions, an area as large as 38 m^2 could be sampled, depending on the wind direction and intensity. It was noticed, for instance, that the sediment texture and colour were not all the same, indicating different sampling sites. It is likely that his variation originated from this sampling effect.

In July 1984 the O_2-concentrations in the deep waters disappeared, though the P-concentrations in such waters at that time did not show any relevant change. Just by the end of August phosphor began to accumulate in the deep waters. This reinforces the influence that under hypolimnetical anaerobic conditions the P-exchangeability from the sediment to the water increases (Li et al., 1972). The P-exchange from sediments to the water's biodynamic cycle depends not only on the iron-phosphate:anaerobic hypolimnetical conditions. Phosphates also have a strong tendency in waters of calcareous regions to be adsorbed to clays and to form insoluble metallic salts, in particular with Ca^{++} (Schäfer, 1984). The pH has a pronounced effect on the exchange rates of phosphate, iron and calcium (Kamp-Nielsen, 1974), aluminium also seems to be an important binding metal for phosphorus (Ku et al., 1978). Lately, several authors have pointed out the role of organisms on the mobilization of sediment phosphorus: freshwater macrophytes (Barko & Smart, 1980), chironomids (Gallepp et al., 1978), and tubificid worms (Davis et al., 1975). However, the apatite-phosphate complex does not seem to play a role in the re-

lease of phosphorus into the deep waters in the Bostal Reservoir, because it is a soft-water reservoir (Zaiss, 1981).

Even though phosphorus concentrations were relatively low during summer in the waters of the Bostal Reservoir during 1983 and 1984, it appears that P-concentrations did not limit phytoplankton growth. If that were the case, one would expect that at the end of the stratification process, at least for the year 1984, a concomitant increase in biomass would occur due to the introduction of phosphate-rich deep water into the system. In 1984 such was not observed as it has been described, for instance, in the case of Lake Erie (Burns & Ross, 1972).

Soluble reactive phosphorus was seldom a major contributor to total P in either 1983 and 1984. The SRP concentrations found at the end of the summer stratification in 1984 in hypolimnetic water did not cause any considerable change in the SRP concentration in the mixed layer as the thermocline descended. This is likely to be related to the small SRP released by the sediments.

Changes in the P-concentration and in the contribution of the other two P-fractions can be explained mostly in terms of the seasonal events. Rising levels of the total P in autumn were coincidental with the end of the stratification period in 1984, as a consequence of the release of phosphorus out of the sediments into the deep waters and the subsequent turnover.

The anomalous high values for total P and total dissol-

ved P found on 4 July 1983 and 23 August 1984, however,can not be easily interpreted. The only occurence common to both dates was the beginning of the summer stratification period. Neverthless, the temperature differences were already, at that time, considerably high (See Fig. 23 for Relative Thermal Resistance for the years 1983 and 1984), thus avoiding any possible turnover that could have been occured. It is perfectly clear that such phosphorus quantities should have been released from the sediments into the water column (at the sampling stations near the brooks total P results were also high). What still remains to be explained is how this phosphorus managed to distribute itself in the whole water column.

It is essential to examine the relationship between phosphorus and nitrogen in order to determine the relative importance of such compounds to phytoplankton cells. Under a large majority of lake conditions these nutrients are most likely to cause a shift from a less to a more productive state (Wetzel, 1983). Therefore, from the point of view of eutrophication, control of the relative proportions of nitrogen and phosphorus may give indication of nutrient limitation as well. It is generally accepted that on average, the tissues of phytoplankton and aquatic macrophytes contain phosphorus and nitrogen atoms in the ratio of 1 P : 16 N. Table VI summarizes the atomic ratio of nitrogen to phosphotus in the Bostal Reservoir. It is obvious that care should be taken in comparing the N:P ratios from literature available, as the methods of analysis employed are not all the

same, and the conditions under which results were obtained are not adequately described. However, the results reported here are closely similar to the figures published by Mitamura & Saijo (1981). They calculated a mean atomic ratio of 1 P:35.8 N and 1 P:22.8 N working at two different stations in Lake Biwa (A=674.8 km^2; z_{max}=104 m). The ratios reported here vary from 15.35 to 53.94.

Table VI

Summary of N and P atomic ratios of the water column, based on samples collected at the three stations on the Bostal Reservoir in 1983 and 1984.

	N:P Ratio	
Depth (m)	1983	1984
0	40.58	40.64
1	42.82	36.61
2	42.73	36.78
3	42.54	37.47
5	43.60	33.91
7	46.62	37.03
9	48.50	38.63
11	53.94	31.65
13	48.58	20.13
16	53.03	15.35

OECD (1982) stated that phosphorus limitation occurs when the N:P atomic ratio in the water is > 16. In this work we have already shown evidence that phosphorus availability does not seem to limit phytoplankton growth in the Bostal Reservoir. Availability implies the ability of the

ecosystem to supply materials by internal biochemical cycles, and it is more relevant than concentration in relation to limiting production in a given ecosystem (Smith, 1984). The area which was flooded for the formation of the Bostal Reservoir had been used intensively as agricultural land and receiving therefore, a constant charge of nutrients as fertilizers. Indeed, sediment analysis show that P and N were always found in higher concentration in the interstitial waters than in the overlying waters. Moreover, such nutrients especially under anaerobic conditions during summer stratification can be released into the surrounding waters. Therefore, we are bound to conclude that phosphorus does not limit phytoplankton growth in the Bostal Reservoir.

We have so far discussed several aspects about the limnology of the Bostal Reservoir. A perhaps more important aspect, as far as the public is concerned, is how we can improve the water quality of the reservoir in the future. This aspect lead us directly to the problem of eutrophication. Eutrophication is the effect in water caused by the oversupply on nutrients, particularly phosphorus and nitrogen. Such oversupply might occur through natural changes (climatical and geological events) or "man-made" eutrophication, termed as cultural eutrophication by Hutchinson (1973). Man-made eutrophication can be reversed by the elimination or reduction of the nutrient supply from sources such as municipal and industrial waste waters, agricultu-

ral wastes and fertilizers (OECD, 1982). The Cooperative Programme on Eutrophication of the OECD* (1971**, 1982) based on many data from the member countries lakes and reservoirs, proposed a model whereby the water quality (trophic status) could be monitored from changes in the nutrient loading. Analisis of 126 water bodies, in four different regions, offered the possibility of classifying lakes and reservoirs based upon water transparency and phosphorus, nitrogen and chl. a concentrations. However, as pointed out by Goldman & Horne (1983) the concept of oligotrophic-eutrophic is applicable only to lakes within one lake district or possibly groups of lake districts. In this investigation it is not reasonable, therefore, to apply such a model in order to classify the Bostal Reservoir as far as the trophic status is concerned. In the reservoir investigated the water leaves the water body when the water level reaches 400 m MSL thorugh the spillway tower. Also, bottom-withdraw is carried out, and outflow measurements have not been conducted by the reservoir's management. Owing to this, it is not possible to apply any eutrophication prediction models in order to make a comparison between other reservoirs and the Bostal Reservoir.

The first priority in the context of reservoirs management is to establish the principal use or uses of the water. Another very important decision in relation to reser-

*OECD - Organization for Economic Co-Operation and Development.

**OECD, 1971 = Vollenweider, 1971.

voir restoration is the answer to the question whether a possible measure for controlling eutrophication is economically and materially feasible. This becomes more relevant when one considers that in some situations recovery time is too long to bring immediate results. In the Bostal Reservoir case a reduction of the abundant and sustained groth of phytoplankton is the primary target, thus leading to an incrased transparency.

The main objective of the Bostal Reservoir was to provide recreational facilities for the northern region of Saarland, therefore for the public concerned the most important feature is the reservoir clear water. In the light of the evidence, the waters of the Bostal Reservoir can be recommended for recreational and bathing purposes without any minor restriction, nonetheless, the introduction of some measures may improve the water quality considerably.

The high production rates in the Bostal Reservoir is due to its morphometric conditions (mean depth = 6.3 m), and a high phosphorus loading derived from the streams running isto the reservoir (Zaiss, 1984). Therefore, it is reasonable to assume that any reduction in the amount of phosphorus available in the reservoir will automatically improve the water quality, and consequently the transparency.

In order to allow repair on the dam and on the spillway tower, the water of the Bostal Reservoir should be drained in late summer 1985. This investigation has demons-

trated that the bottom mud is very rich in nutrients. The upper sediments, at least near the tower, where O_2 depletion occurs during summer, should be removed. This measure would help to decrease the release of nutrients, namely phosphorus from the sediments into the water, thus reducing primary production on the basis of phosphorus limitation. The investment costs of dredging could be alleviated by offering such organically rich soil to farmers nearby.

Kaltwasser & Zaiss (1980) recommended the release of deep water through the ground outlet or the construction of an Olszewski pipe. We believe that the release of deep water during the summer stratification, would reduce the phosphorus content of water, thus improving water quality. Indeed, after the installation of an Olszewski pipe in the hypolimnion of the southern part of the Kartowskie Lake, Poland, the water in this part of the lake was found to be less eutrophic due to the removal of large amounts of nitrogen and phosphorus compounds, especially in the summer months (Mientke, 1977a,b,c). However, the water balance in the Bostal Reservoir during the summer months is negative. It is necessary to mention here that the function of the spillway tower is to release any water surpassing 400 m above MSL. The construction of a close-system on this tower would allow the reservoir to accumulate some more water in the winter and spring, thus releasing deep water more frequently, through the deep outflow, during the stratification period in summer (June-September).

The aeration of the hypolimnion with O_2 is not recommended here. Apart of the high costs involved in the operation, the summer hypolimnetic aeration may lead to almost no oxygen during the winter if the aerator is turned off in the autumn (McQueen et al., 1984).

Mechanical resuspension of sediment by wind action should increase the mobilization of phosphorus during the first stages of refilling of the reservoir. If the reservoir is due to be open again to the public next year, it is necessary to carry out a limnological study near the spillway tower at least, in order to supply information about the possible changes caused by the emptying and refilling of the water body.

SUMMARY

Several limnological and physico-chemical variables in the Bostal Reservoir, a man-made lake in the northern Saarland were studied between June 1983 and December 1984. The water body behaves to some extent like a dimictic lake showing an anoxic hypolimnion and thermal stratification during the summer months.

The areal hypolimnetic oxygen deficit was 215 and 338 $mg.m^{-2}.day^{-1}$ for 1983 and 1984 respectively.

Chl. a values and primary production rates were high at the time of high solar intensity rates. The assimilation per unit chl. a ranged from 0.67 to 9.02 mg C.mg chl. $a.h^{-1}$ and the highest primary production rates were measured in August in both years.

Nitrogen was always present in the water and in the interstitial water in enough quantities.

Even though phsophorus concentrations were relatively low during summer 1983 and 1984, it appears that the P-concentration did not limit phytoplankton growth.

The release of phosphorus from the sediments in 1984 may be due to a longer anaerobic hypolimnion.

The waters of the Bostal Reservoir can be recommended for recreational and bathing activities without any minor restriction.

The release of deep water through the ground outlet or the construction of an Olszewski pipe is recommended, especially during the summer months, to eliminate anoxic water rich in ammonium and phosphorus (Kaltwasser & Zaiss, 1980).

The reservoir was drained in the summer 1985 and will be refilled in 1986. Hydromechanical process through the wind action on the small water body during the refilling phase may lead to the remobilization of phosphorus from the sediments. Thus causing a possible change on its trophic degree. Therefore, to follow that, it is here recommended a limmnological study, at least near the spillway-tower to evaluate any negative changes in the water body.

ZUSAMMENFASSUNG

Verschiedene limnologische und physikalisch-chemische Parameter des Bostalsees, eines saarländischen Stausees, wurden zwischen Juni 1983 und Dezember 1985 beschrieben.

Der Stausee erweist sich als ein dimiktischer See, mit anaerobem Hypolimnion und thermaler Schichtung während der Sommermonate.

Das flächenbezogene hypolimnische Sauerstoffdefizit lag zwischen 215 und 338 $mg.m^{-2}.Tag^{-1}$ im Jahr 1983 bzw. 1984.

Chl. a-Werte und Primärproduktionsrate waren während der hohen Sonneintensitätsrate ebenfalls hoch. Die Relation Assimilation bzw. Primärproduktion:Chl. a variierte von 0.67 bis 9.02 mg C.mg $Chl.a.h^{-1}$ und die höchste Primärproduktionsrate wurde im August beider Jahre nachgewiesen.

Stickstoff wurde immer im ausreichender KOnzentration im Wasser und im Sediment (interstitiales Wasser) festgestellt.

Trotz seiner relativ geringen Konzentration während der Sommermonate erwies sich Phosphor nicht als entscheidender wachstumregulierender Faktor im Stausee.

Die P-Eintragung vom Sediment ins Wasser während des Jahres 1984 ist wahrscheinlich auf den längeren anaeroben Zustand der unteren Wasserschichten zurückzuführen.

Der Bostalsee kann ohne weiteres zur Erholung zum Baden und für sportliche Aktivitäten genutzt werden.

Das phosphat- und ammoniumreiche, anaerobe Tiefenwasser sollte vor allem während der Sommermonate über den Grundablaß oder durch ein eingebautes Olszewski-Rohr entfernt werden (Kaltwasser & Zaiß, 1980).

Der Stausee wurde im Sommer 1985 abgelassen und wird voraussichtlich erst 1986 wieder aufgestaut werden. Hydromechanische Prozess durch den verstärkten Windeinfluß auf den kleinen Wasserkörper während des Aufstaus können dabei zu einer Remobilisierung des Phosphates im Sediment führen, verbunden mit einem möglichen Anstieg des Trophiegrades. Es wird daher empfohlen, eine limnologische Studie im Zusammenhang mit dem Aufstau durchzuführen, zumindest im Bereich des Auslauf-

turms, um etwaige negative Entwicklungen zu erkennen und ihnen zu begegnen.

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APPENDIX

Table A-I

Summary of Analysis of Variance conducted on total phosphorus data for the year 1983 and 1984. Results represent average values from samples collected at three stations at different depths.

ANOVA

Source of variance	SS	DF	MS
Total	22.99	19	-
Groups	8.57	1	8.57
Error	14.42	18	0.80

F=Groups MS/Error MS

F=10.71

$F_{0.05\ 1,19} = 4.38$ $F_{0.01\ 1,19} = 8.18$

Reject H_o. $p > 0.01$

Table A-II

Summary of Analysis of Variance conducted on total dissolved phosphorus data for the year 1983 and 1984. Results represent average values from samples collected at three stations at different depths.

ANOVA

Source of variance	SS	DF	MS
Total	12.47	19	-
Groups	3.09	1	3.09
Error	9.37	18	0.52

F= Groups MS/Error MS

F=5.94

$F_{0.05\ 1,19} = 4.38$ $F_{0.01\ 1,19} = 8.18$

Accept H_o. $p < 0.05$

Table A-III

Summary of Analysis of Variance conducted on soluble reactive phosphorus data for the year 1983 and 1984. Results represent average values from samples collected at three stations at different depths.

ANOVA

Source of variance	SS	DF	MS
Total	0.808	19	-
Groups	0.242	1	0.242
Error	0.566	18	0.031

F=Groups MS/Error MS

F= 8.06

$F_{0.05\ 1,19} = 4.38$ $F_{0.01\ 1,19} = 8.18$

Accept H_o. $p < 0.05$

Table A-IV

Summary of Analysis of Variance conducted on total organic nitrogen data for the years 1983 and 1984. Results represent average values from samples collected at three stations at different depths.

ANOVA

Source of variance	SS	DF	MS
Total	434.4	19	-
Groups	171.4	1	171.4
Error	263.0	18	14.61

F=Groups MS/Error MS

F= 11.73

$F_{0.05\ 1,19} = 4.38$ $F_{0.01\ 1,19} = 8.18$

Reject H_o. $p > 0.01$

Table A-V

Summary of Analysis of Variance conducted on total nitrogen data for the years 1983 and 1984. Results represent average values from samples collected at three stations at different depths.

ANOVA

Source of variance	SS	DF	MS
Total	1667.8	19	-
Groups	1004.5	1	1004.5
Error	663.33	18	36.85

F= Groups MS/Error MS

F= 27.25

$F_{0.05\ 1,19} = 4.38$ $F_{0.01\ 1,19} = 8.18$

Reject H_o. $p > 0.01$

Table A-VI

Summary of Analysis of Variance conducted on nitrite data for the years 1983 and 1984. Results represent average values from samples collected at three stations at different depths.

ANOVA

Source of variance	SS	DF	MS
Total	0.0797	19	-
Groups	0.0354	1	0.0354
Error	0.0443	18	0.00246

F= Groups MS/Error MS

F= 14.39

$F_{0.05\ 1,19} = 4.38$ $F_{0.01\ 1,19} = 8.18$

Reject H_o. $p > 0.01$

Table A-VII

Summary of Analysis of Variance conducted on nitrate data for the years 1983 and 1984. Results represent average values from samples collected at three stations at different depths.

ANOVA

Source of variance	SS	DF	MS
Total	934	19	-
Groups	519.9	1	519.9
Error	414.1	18	23.0

F= Groups MS/Error MS

F= 22.60

$F_{0.05\ 1,19} = 4.38$ $F_{0.01\ 1,19} = 8.18$

Reject H_o. $p > 0.01$

Table A-VIII

Summary of Analysis of Variance conducted on ammonium data for the years 1983 and 1984. Results represent average values from samples collected at three stations at different depths.

ANOVA

Source of variance	SS	DF	MS
Total	411.82	19	-
Groups	33.43	1	33.43
Error	378.39	18	21.02

F= Groups MS/Error MS

F= 1.59

$F_{0.05\ 1,19} = 4.38$ $F_{0.01\ 1,19} = 8.18$

Accept H_o. $p < 0.01$

TABLE A IX

Seasonal variation of total phosphorus in the interstitial water of the Bostel Reservoir.

station \ date	03.06.83	18.06.83	04.07.83	21.07.83	03.08.83	25.08.83	20.09.83	13.10.83	03.11.83	08.12.83	01.04.84	17.04.84	10.05.84
I	28.17	42.15	33.19	13.70	19.25	17.74	25.66	28.29	18.75	17.41	29.88	30.18	32.9
II	34.12	37.18	32.17	23.33	22.45	45.79	19.04	37.91	22.83	23.16	29.16	33.17	12.83
III	19.31	25.16	23.17	24.50	17.29	24.20	21.66	21.00	18.70	21.16	31.15	39.18	12.54

station \ date	25.05.84	07.06.84	26.06.84	11.07.84	26.07.84	09.08.84	23.08.84	08.09.84	25.09.84	25.10.84	27.11.84	14.12.84	-
I	26.54	13.70	102.08	56.80	31.50	12.54	33.17	18.87	14.08	-	-	-	
II	35.00	81.37	58.33	78.75	25.66	9.04	31.42	18.95	16.62	35.01	37.60	44.62	
III	36.16	13.70	45.83	35.00	13.83	11.66	23.12	21.80	14.88	-	-	-	

TABLE A-X

Seasonal variation of total nitrogen in the interstitial waters of the Bostal Reservoir.

date / station	03.06.83	18.06.83	04.07.83	21.07.83	03.08.83	25.08.83	20.09.83	13.10.83	03.11.83	08.12.83	01.04.84	17.04.84	10.05.84
I	193.33	117.01	132.18	71.04	89.17	115.57	514.02	694.10	206.21	199.17	201.17	238.31	257.69
II	82.15	86.17	79.48	82.58	178.15	203.40	215.96	581.77	313.18	244.28	239.16	243.27	109.19
III	147.15	241.17	231.15	218.83	369.43	256.80	649.96	506.93	444.83	313.17	301.48	298.17	190.44

date / station	25.05.84	07.06.84	26.06.84	11.07.84	26.07.84	09.08.84	23.08.84	08.09.84	25.09.84	25.10.84	27.11.84	14.12.84	-
I	431.52	344.59	283.17	308.16	269.75	217.16	301.01	57.74	291.37	-	-	-	
II	623.00	639.10	498.16	333.15	193.64	280.72	299.12	104.22	407.57	199.32	768.62	736.68	
III	678.13	372.98	383.17	292.19	182.46	592.09	199.10	183.17	275.40	-	-	-	

DATE: 03 06 '83

NOWEMS Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{-3}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	14.1	9.2	1.12	0.22	19.85	14.24	36.21	0.45	0.81	1.02	11.92	-	-
1.1	14.1	9.2	0.99	0.24	20.87	14.11	36.24	0.74	0.93	1.09	11.79	77.17	9.83
1.2	13.4	9.2	1.01	0.26	21.34	14.21	37.01	0.78	0.92	1.05	12.01	-	-
1.3	13.4	9.2	1.10	0.26	21.34	14.21	37.01	0.87	0.94	1.07	10.87	27.74	3.03
1.4	13.4	9.2	1.07	0.26	21.32	14.21	36.80	0.91	1.04	1.30	10.22	10.04	1.08

SECCHI DISC DEPTH: (cm) 140

2.0	14.1	9.2	1.10	0.26	20.90	14.47	36.49	0.55	0.83	0.99	12.32	-	-
2.1	14.1	9.2	0.99	0.24	21.76	14.25	37.17	0.60	0.77	0.87	12.47	84.10	8.75
2.2	14.1	9.2	1.07	0.26	21.82	14.32	37.39	0.71	0.96	1.09	12.27	-	-
2.3	13.4	9.2	1.01	0.25	20.90	14.64	37.07	0.69	0.89	1.06	11.42	31.16	2.91
2.4	13.4	9.2	1.07	0.24	21.80	14.69	38.02	0.72	0.92	1.17	10.71	11.72	1.09
2.5	13.4	9.2	1.01	0.24	21.29	14.30	37.12	0.59	0.87	1.12	10.12	-	-
2.6	13.4	9.2	2.34	0.24	21.17	14.79	38.29	0.57	0.80	1.09	9.80	3.91	0.39
2.11	11.2	5.2	3.47	0.26	20.99	14.79	39.01	0.54	0.83	1.07	9.81	-	-
2.13	8.7	4.8	4.74	0.39	21.82	12.34	39.24	0.49	0.69	1.00	6.92	-	-
2.16	8.2	4.8	4.89	0.39	21.99	13.71	40.98	0.45	0.70	0.92	7.16	-	-

SECCHI DISC DEPTH (cm) 130

3.0	14.1	9.2	0.99	0.23	21.24	14.15	37.21	0.73	0.89	1.06	12.15	-	-
3.1	14.1	9.2	1.04	0.25	21.09	14.53	36.91	0.81	0.89	1.04	12.01	79.12	7.65
3.2	14.0	8.9	1.07	0.25	20.13	15.03	36.54	0.77	0.89	1.12	11.49	-	-
3.3	13.8	9.1	1.09	0.27	21.01	14.56	36.93	0.70	1.01	1.40	11.39	29.17	3.81
3.4	13.8	9.1	1.27	0.27	22.07	14.56	38.17	0.79	1.01	1.19	11.11	10.61	1.43

SECCHI DISC DEPTH (cm) 130

DATE: 18 06 '83

Depth m	Temperature °C	Dissolved Oxygen mg $O_2.dm^{-3}$	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg $C.m^{-3}.h^{-1}$	Extracellular Carbon Release
1.0	17.0	9.0	1.90	0.22	18.17	17.00	37.29	0.39	0.49	1.01	15.87	-	-
1.1	17.1	8.9	2.01	0.26	18.10	17.11	37.48	0.37	0.58	0.99	15.39	110.87	8.78
1.2	17.0	8.9	1.96	0.25	18.23	17.54	37.98	0.41	0.70	0.84	14.46	-	-
1.3	17.0	8.8	2.10	0.27	18.25	17.66	38.28	0.78	0.91	1.02	13.79	37.11	4.12
1.4	16.9	8.3	2.10	0.28	18.25	18.54	39.17	0.80	1.02	1.07	13.79	16.34	1.01

SECCHI DISC DEPTH:(cm) 110

2.0	17.2	8.9	1.89	0.22	18.17	16.92	37.20	0.47	0.80	1.01	16.01	-	-
2.1	17.1	8.9	2.10	0.21	18.21	17.29	37.81	0.49	0.77	1.13	16.12	122.01	11.1
2.2	17.0	8.8	2.06	0.24	18.09	17.01	37.40	0.32	0.79	1.08	15.38	-	-
2.3	16.7	8.3	2.11	0.24	18.16	16.58	37.09	0.47	0.71	1.11	15.28	29.12	2.9
2.5	14.5	7.1	2.32	0.23	18.21	18.32	39.08	0.48	0.72	1.03	14.93	11.17	0.99
2.7	13.3	6.4	3.99	0.26	18.09	16.03	38.37	0.49	0.72	1.11	10.98	-	-
2.9	12.0	6.4	4.17	0.29	18.01	17.30	39.77	0.55	0.81	1.07	8.88	3.93	0.22
2.11	11.1	5.2	5.91	0.29	17.01	14.71	40.91	0.63	0.99	1.17	7.74	-	-
2.13	10.5	3.9	8.90	0.29	15.09	16.81	41.09	0.70	1.06	1.22	6.83	-	-
2.16	9.0	3.9	11.32	0.30	14.17	17.07	42.86	0.70	1.06	1.22	6.12	-	-

SECCHI DISC DEPTH (cm) 120

3.0	17.2	9.0	1.92	0.24	18.39	17.26	37.83	0.46	0.73	1.01	15.75	-	-
3.1	17.2	8.9	1.89	0.23	18.41	17.26	37.81	0.53	0.81	0.99	15.92	119.08	9.83
3.2	17.2	8.9	2.01	0.24	18.31	16.99	37.55	0.57	0.87	1.11	15.16	-	-
3.3	16.9	8.6	2.00	0.24	18.27	16.78	37.29	0.51	0.86	1.12	14.93	31.12	3.17
3.4	16.9	8.6	1.96	0.24	18.16	19.81	40.17	0.52	0.86	1.21	14.91	12.09	1.81

SECCHI DISC DEPTH (cm) 120

DATE: 18 06 '83

Depth m	Temperature °C	Dissolved Oxygen $mg\ O_2.dm^{-3}$	Ammonium $\mu g\ at\ NH_3\text{-}N.dm^{-3}$	Nitrite $\mu g\ at\ NO_2^-\text{-}N.dm^{-3}$	Nitrate $\mu g\ at\ NO_3^-\text{-}N.dm^{-3}$	Total Organic Nitrogen $\mu g\ at\ N.dm^{-3}$	Total Nitrogen $\mu g\ at\ N.dm^{-3}$	Soluble Reactive Phosphor $\mu g\ at\ PO_4\text{-}P.dm^{-3}$	Total Dissolved Phosphor $\mu g\ at\ P.dm^{-3}$	Total Phosphor $\mu g\ at\ P.dm^{-3}$	Chlorophyll a $\mu g.dm^{-3}$	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release percent
1.	[illegible]	[illegible]	1.90	0.22	18.17	17.00	37.29	0.39	0.49	1.01	15.07	-	-
[illegible]	[illegible]	[illegible]	[illegible]	0.26	18.10	17.11	37.48	0.37	0.58	0.99	15.29	110.87	8.78
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18.23	17.54	37.98	0.41	0.70	0.99	14.98	-	-
[illegible]	[illegible]	[illegible]	[illegible]	0.27	18.25	17.66	38.28	0.78	0.91	1.12	13.79	37.11	4.12
[illegible]	[illegible]	[illegible]	[illegible]	0.25	18.25	18.54	39.17	0.80	1.02	1.07	13.79	10.91	1.01

SECCHI DISC DEPTH: (cm) 110

[illegible]	17.2	8.9	1.89	0.22	18.17	16.92	37.20	0.47	0.80	1.01	16.01	-	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	17.0	8.8	2.06	0.24	18.09	17.01	37.40	0.32	0.79	1.08	15.98	-	-
2.3	16.7	8.3	2.11	0.24	18.16	16.58	37.09	0.47	0.71	1.11	15.28	29.12	2.93
2.5	14.5	7.1	2.32	0.23	18.21	18.32	39.08	0.48	0.72	1.03	14.93	11.17	0.99
2.7	13.3	6.4	3.99	0.26	18.09	16.03	38.37	0.49	0.72	1.11	10.98	-	-
2.9	12.0	6.4	4.17	0.29	18.01	17.30	39.77	0.55	0.81	1.07	8.88	3.93	0.22
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
2.16	9.0	3.9	11.32	0.30	14.17	17.07	42.86	0.70	1.06	1.22	6.12	-	-

SECCHI DISC DEPTH (cm) 120

3.0	17.2	9.0	1.92	0.24	18.39	17.26	37.83	0.46	0.73	1.01	15.75	-	-
3.1	17.2	8.9	1.89	0.23	18.41	17.26	37.81	0.53	0.81	0.99	15.92	119.08	9.83
3.2	17.2	8.9	2.01	0.24	18.31	16.99	37.55	0.57	0.87	1.11	15.16	-	-
3.3	16.9	8.6	2.00	0.24	18.27	16.78	37.29	0.51	0.86	1.12	14.93	31.12	3.17
3.4	16.9	8.6	1.96	0.24	18.16	19.81	40.17	0.52	0.86	1.21	14.91	12.09	1.81

SECCHI DISC DEPTH (cm) 120

DATE: 04 07 '83

Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	18.2	9.0	2.61	0.53	15.47	20.78	39.39	0.66	3.37	3.91	15.31	-	-
1.1	18.0	9.1	2.53	0.51	14.78	21.06	38.88	0.62	3.40	3.89	15.17	127.12	9.67
1.2	18.0	9.0	2.40	0.53	15.20	21.56	39.69	0.70	3.30	3.70	15.16	-	-
1.3	17.0	8.8	2.69	0.47	14.78	22.67	40.61	0.71	3.00	3.66	14.98	39.17	3.31
1.4	17.0	8.9	2.69	0.47	14.28	24.19	41.63	0.73	2.91	3.30	14.69	9.81	1.79

SECCHI DISC DEPTH:(cm) 190

2.0	19.2	9.2	2.32	0.49	15.21	21.79	39.81	0.62	4.04	4.41	15.29	-	-
2.1	19.2	9.3	2.24	0.32	14.97	21.86	39.39	0.64	4.12	4.82	15.31	98.12	10.17
2.2	19.1	9.3	2.81	0.49	15.23	22.58	40.91	0.71	4.02	4.29	15.23	-	-
2.3	18.6	8.6	3.41	0.47	16.27	21.68	41.83	0.69	3.99	4.17	15.48	91.16	8.14
2.5	16.1	8.6	2.77	0.47	18.22	22.25	43.71	0.71	3.16	3.42	15.12	13.12	1.20
2.7	13.8	8.0	6.50	0.49	18.16	24.66	49.81	0.69	3.29	4.01	11.17	-	-
2.9	11.9	5.0	7.67	0.96	18.99	29.55	57.17	0.65	3.31	4.01	9.81	4.16	0.36
2.11	11.0	4.8	11.52	0.55	16.57	34.53	63.17	0.63	3.70	4.17	7.96	-	-
2.13	10.4	3.7	18.23	0.63	14.54	32.03	65.43	0.59	4.41	4.90	6.61	-	-
2.16	9.2	3.6	23.17	0.67	10.08	42.36	76.28	0.56	3.37	4.16	5.92	-	-

SECCHI DISC DEPTH (cm) 290

3.0	20.4	8.9	2.24	0.47	14.60	21.64	38.98	0.68	3.51	3.98	14.91	-	-
3.1	20.0	8.9	2.24	0.49	13.35	24.83	40.91	0.66	3.31	4.01	15.17	102.12	8.93
3.2	19.6	9.1	2.24	0.51	12.43	25.51	40.79	0.59	3.41	4.07	15.22	-	-
3.3	18.7	8.9	2.24	0.51	14.54	23.62	40.91	0.63	3.42	3.99	14.98	63.14	5.42
3.4	16.4	9.9	2.24	0.51	12.28	27.34	42.37	0.64	3.57	4.12	14.86	9.81	1.07

SECCHI DISC DEPTH (cm) 260

DATE: 21 07 '83

Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	7.9	3.49	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	7.9	3.93	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SECCHI DISC DEPTH: (cm) 105

2.0	23.9	8.3	3.53	0.49	15.50	33.65	53.17	0.75	0.87	2.66	10.06	-	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2.2	24.0	7.9	3.37	0.49	15.05	35.21	54.12	0.87	0.87	1.10	12.20	-	-
2.3	24.0	7.9	3.41	0.47	15.65	35.45	54.98	0.95	1.01	1.19	12.29	12.12	1.97
2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.24	8.88	7.51	1.39
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.26	8.88	-	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.33	8.14	3.20	[illegible]
2.11	12.1	2.9	18.52	0.55	5.32	47.04	71.43	0.66	0.79	1.33	7.70	-	-
2.13	11.2	2.7	21.52	0.63	2.21	55.44	79.80	0.66	0.79	1.70	3.96	-	-
2.16	11.1	1.1	28.35	0.67	1.11	68.12	98.25	0.50	0.79	2.20	3.98	-	-

SECCHI DISC DEPTH (cm) 120

3.0	23.5	9.2	3.41	0.47	14.58	32.77	51.23	0.70	0.87	1.29	8.88	110.99	7.83
3.1	23.4	9.0	3.05	0.49	15.29	36.59	55.42	0.70	0.87	1.20	10.06	-	-
3.2	23.0	9.0	3.45	0.51	15.08	34.23	53.27	0.75	0.87	1.25	11.84	9.12	1.02
3.3	23.0	8.6	3.05	0.51	14.17	40.08	58.41	0.70	0.87	1.25	9.47	-	-
3.4	20.0	6.3	11.88	0.51	7.32	43.71	63.42	0.87	1.32	1.70	8.24	5.47	0.11

SECCHI DISC DEPTH (cm) 160

DATE: 03 08 '83

Station Depth m	Temperature °C	Dissolved Oxygen mg $O_2.dm^{-3}$	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg $C.m^{-3}.h^{-1}$	Exracellular Carbon Release percent
1.0	21.0	7.9	3.53	0.32	7.75	50.12	61.72	0.83	1.62	1.25	10.08	-	-
1.1	21.0	7.6	5.06	0.49	7.94	51.49	64.53	0.87	1.66	1.34	13.02	106.01	13.17
1.2	21.0	7.6	3.73	0.40	8.25	51.19	62.73	0.70	1.66	1.25	13.22	-	-
1.3	21.0	7.8	3.89	0.32	8.37	52.06	64.64	0.54	1.83	1.33	15.04	49.11	5.99
1.4	21.0	8.0	3.37	0.36	7.75	54.30	65.84	0.54	1.86	1.41	10.10	22.11	2.11

SECCHI DISC DEPTH:(cm) 0.95

2.0	21.0	8.91	3.29	0.36	8.25	53.97	65.87	0.33	0.66	1.08	15.3	-	-
2.1	21.0	9.40	2.12	0.40	8.34	53.47	64.33	0.54	0.62	1.04	10.2	103.17	11.41
2.2	21.0	10.06	2.57	0.42	8.16	54.18	65.33	0.45	0.70	1.12	11.3	-	-
2.3	21.0	9.36	2.81	0.40	8.27	56.90	67.48	0.41	0.62	1.29	13.5	48.15	3.37
2.5	19.8	9.43	2.53	0.44	7.66	57.81	68.44	0.37	0.70	1.00	14.3	24.12	2.14
2.7	15.7	1.14	15.06	0.30	7.24	46.68	69.28	0.37	0.70	1.00	5.92	-	-
2.9	12.0	0.91	16.62	0.35	7.12	52.08	74.17	0.62	0.70	1.00	4.37	7.15	1.01
2.11	11.5	0.42	34.13	0.40	4.37	56.35	85.25	0.33	0.62	1.37	4.37	-	-
2.13	11.0	0.85	32.34	0.42	0.91	60.51	94.18	0.33	0.62	1.39	4.01	-	-
2.16	11.0	0.39	32.93	0.42	0.83	73.06	107.24	0.41	0.70	1.42	3.99	-	-

SECCHI DISC DEPTH (cm) 115

3.0	21.0	8.6	4.29	0.36	8.37	51.18	64.20	0.70	0.66	1.45	15.9	-	-
3.1	21.0	6.2	5.30	0.51	8.94	50.14	64.89	0.62	0.79	1.33	12.7	109.01	12.16
3.2	21.0	8.6	4.29	0.49	9.15	51.53	65.46	0.58	0.79	1.37	17.3	-	-
3.3	20.5	8.7	4.29	0.44	8.93	52.62	66.28	0.83	0.87	1.33	15.28	66.15	7.61
3.4	20.0	9.93	4.38	0.42	8.97	57.89	71.66	0.79	0.87	1.37	15.28	24.17	1.93

SECCHI DISC DEPTH (cm) 120

DATE: 25 08 '83

KOMPAS Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{-3}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	18.3	8.5	1.38	.32	9.74	69.37	80.51	0.41	0.71	1.62	9.83	-	-
1.1	17.9	8.1	0.93	0.49	9.12	74.97	85.51	0.50	0.72	1.62	10.27	198.1	15.16
1.2	17.8	8.5	.1.1	0.4	8.34	76.01	86.35	0.50	0.82	1.62	11.29	-	-
1.3	17.9	8.1	1.24	0.32	8.45	76.35	86.00	0.54	0.84	1.62	11.35	99.82	12.01
1.4	17.8	8.5	1.26	0.36	8.12	80.46	91.20	0.50	0.79	1.52	10.22	28.17	2.31

SECCHI DISC DEPTH: (cm) 100

2.0	18.3	8.	1.14	0.36	8.71	71.26	82.77	0.45	0.65	1.20	10.81	-	-
2.1	18.5	8.3	1.2	0.40	8.68	78.03	89.03	0.54	0.58	1.30	10.99	169.41	12.21
2.2	18.5	8.	1.20	0.42	9.74	76.38	87.34	0.45	0.71	1.33	12.75	-	-
2.3	18.5	8.5	1.4	0.4	11.61	77.04	89.58	0.54	0.48	1.75	12.29	110.17	11.17
2.5	18.3	8.1	1.29	0.44	8.83	77.13	81.98	0.29	0.5	1.25	7.30	8.98	0.6
2.7	17.9	8.0	1.32	0.40	8.85	86.09	104.16	0.29	0.5	1.5	3.4	-	-
2.9	18.3	8.7	1.34	0.40	8.82	83.38	94.12	0.45	0.3	1.0	2.31	2.25	0.19
2.11	18.1	8.6	1.70	0.44	9.15	86.12	97.19	0.41	0.33	1.5	2.45	-	-
2.13	18.3	8.	1.66	0.40	9.08	87.74	105.15	0.27	0.69	1.38	2.79	-	-
2.16	18.7	8.4	1.91	0.44	8.88	82.44	93.27	0.45	0.3	1.38	3.17	-	-

SECCHI DISC DEPTH (cm) 100

3.0	18.3	8.0	1.68	0.36	8.34	70.42	81.40	0.45	0.69	1.20	10.66	-	-
3.1	18.3	8.8	1.12	0.51	9.77	73.16	84.56	0.58	0.69	1.33	11.41	174.1	13.17
3.2	18.2	9.6	1.40	0.49	9.18	79.41	90.48	0.58	0.71	1.4	12.6	-	-
3.3	17.9	9.8	1.76	0.44	8.34	85.79	96.33	0.54	0.83	1.10	12.38	101.4	10.15
3.4	17.9	7.6	1.48	0.42	8.43	89.51	99.84	0.50	0.71	1.17	12.30	53.1	2.83

SECCHI DISC DEPTH (cm) 95

DATE: 20 09 '83

Depth m	Temperature °C	Dissolved Oxygen $mg\ O_2.dm^{-3}$	Ammonium μg at NH_3-$N.dm^{-3}$	Nitrite μg at NO_2^--$N.dm^{-3}$	Nitrate μg at NO_3^--$N.dm^{-3}$	Total Organic Nitrogen μg at $N.dm^{-3}$	Total Nitrogen μg at $N.dm^{-3}$	Soluble Reactive Phosphor μg at PO_4^{3-}-$P.dm^{-3}$	Total Dissolved Phosphor μg at $P.dm^{-3}$	Total Phosphor μg at $P.dm^{-3}$	Chlorophyll a $\mu g.dm^{-3}$	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release percent
1.0	14.0	8.9	7.22	0.36	13.02	86.38	106.98	0.50	1.41	1.54	6.25	-	-
1.1	13.9	8.0	7.74	0.41	13.02	99.38	120.54	0.54	1.37	1.41	6.44	33.01	3.33
1.2	13.9	8.3	7.85	0.32	13.02	112.84	134.03	0.45	1.17	1.45	5.96	-	-
1.3	13.7	8.3	7.79	0.30	12.52	107.03	127.64	0.54	1.06	1.16	5.98	10.92	1.07
1.4	13.6	8.3	9.31	0.30	12.93	109.00	131.54	0.54	1.25	1.50	6.01	3.53	0.49

SECCHI DISC DEPTH:(cm) 140

2.0	14.0	10.8	9.71	0.38	13.35	81,13	104.57	0.50	0.83	1.08	6.80	-	-
2.1	14.0	10.8	6.34	0.26	13.41	90.05	110.06	0.50	1.17	1.45	7.69	17.95	2.10
2.2	13.9	9.8	10.13	0.32	13.57	79.79	103.87	0.50	1.17	1.41	6.80	-	-
2.3	13.9	9.3	7.26	0.30	13.56	106.16	127.28	0.45	1.17	1.41	7.06	3.80	0.33
2.5	11.0	9.7	7.51	0.32	13.47	104.28	125.33	0.45	1.41	1.50	7.40	-	-
2.7	10.8	9.5	7.83	0.32	13.27	100.90	122.32	0.45	1.41	1.50	5.32	3.69	0.31
2.9	10.2	9.4	6.62	0.32	13.08	107.40	127.42	0.45	1.41	1.57	5.32	-	-
2.11	9.9	9.4	8.47	0.34	12.39	122.05	143.25	0.50	1.41	1.55	5.62	3.80	0.31
2.13	9.7	9.4	8.70	0.34	11.71	128.00	148.75	0.50	1.33	1.57	5.32	-	-
2.16	8.8	9.0	9.27	0.38	10.07	142.92	162.64	0.58	1.33	1.66	4.14	-	-

SECCHI DISC DEPTH (cm) 140

3.0	14.1	8.4	6.42	0.32	13.28	84.30	104.32	0.50	1.17	1.30	7.59	-	-
3.1	13.9	8.0	6.66	0.34	13.52	88.02	108.54	0.50	1.06	1.12	4.44	56.97	4.61
3.2	13.9	8.3	9.95	0.34	13.37	107.17	130.83	0.50	1.00	1.29	4.44	-	-
3.3	13.9	8.8	11.28	0.26	12.22	91.64	115.40	0.50	1.06	1.33	4.35	7.66	0.82
3.4	13.9	8.7	10.92	0.28	12.16	103.04	126.40	0.50	1.31	1.45	3.99	4.57	0.51

SECCHI DISC DEPTH (cm) 150

DATE: 13 10 '83

STATION Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	13.0	11.3	6.54	0.65	19.33	48.29	74.51	0.49	0.52	1.00	5.99	-	-
1.1	12.4	9.3	8.23	0.63	18.63	48.13	76.62	0.48	0.50	1.04	5.32	17.34	3.98
1.2	12.6	8.3	7.15	0.65	19.45	43.51	70.76	0.47	0.48	1.08	5.90	-	-
1.3	12.8	8.6	8.21	0.53	18.79	48.35	77.88	0.46	0.52	1.08	5.69	7.64	2.16
1.4	12.8	8.5	8.15	0.49	19.54	45.69	73.87	0.50	0.52	1.08	5.50	5.20	1.45

SECCHI DISC DEPTH:(cm) 140

2.0	12.8	12.6	7.20	0.48	18.34	47.52	74.08	0.34	0.54	1.00	5.38	-	-
2.1	12.8	12.4	7.25	0.53	18.65	48.72	73.85	0.47	0.52	1.00	6.02	21.29	3.41
2.2	12.8	12.5	7.34	0.55	18.47	43.89	78.65	0.39	0.52	1.00	5.17	-	-
2.3	12.8	12.5	7.37	0.51	18.59	41.43	79.00	0.43	0.53	1.04	5.91	11.56	2.47
2.5	11.8	11.3	8.23	0.59	18.37	48.37	75.56	0.44	0.50	1.16	5.81	3.98	2.01
2.7	11.7	11.4	7.79	0.59	19.27	46.59	78.64	0.46	0.52	1.00	5.45	-	-
2.9	11.6	11.2	8.51	0.62	18.25	45.72	72.83	0.48	0.54	1.00	5.02	7.65	1.65
3.11	11.3	9.6	8.69	0.59	18.79	46.72	77.79	0.46	0.54	1.00	4.43	-	-
3.13	11.1	9.5	8.31	0.59	19.66	47.14	75.84	0.46	0.54	1.00	4.71	-	-
3.16	11.0	9.1	7.22	0.59	19.48	48.63	75.42	0.48	0.54	1.00	4.72	-	-

SECCHI DISC DEPTH (cm) 140

3.0	13.0	12.8	6.62	0.63	20.10	47.37	75.22	0.41	0.56	1.08	5.81	-	-
3.1	13.0	10.1	7.22	0.61	19.46	51.47	78.80	0.44	0.56	1.00	5.15	3.57	2.17
3.2	12.9	8.4	7.14	0.44	18.43	51.52	77.53	0.44	0.52	1.04	5.89	-	-
3.3	12.9	8.2	7.26	0.53	19.36	48.77	76.42	0.43	0.52	1.00	5.37	4.1	2.01
3.4	12.9	8.2	6.10	0.44	19.83	48.02	74.39	0.40	0.54	1.00	5.43	3.1	1.1

SECCHI DISC DEPTH (cm) 140

DATE: 03 11 '83

Samples Depth m	Temperature °C	Dissolved Oxygen $mg\ O_2.dm^{-3}$	Ammonium μg at NH_3-N.dm^{-3}	Nitrite μg at NO_2^--N.dm^{-3}	Nitrate μg at NO_3^--N.dm^{-3}	Total Organic Nitrogen μg at N.dm^{-3}	Total Nitrogen μg at N.dm^{-3}	Soluble Reactive Phosphor μg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor μg at P.dm^{-3}	Total Phosphor μg at P.dm^{-3}	Chlorophyll a $\mu g.dm^{-3}$	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release
1.0	8.0	11.9	6.07	0.55	29.80	24.16	60.58	0.62	0.64	1.04	5.0	-	-
1.1	8.0	11.9	6.46	0.53	31.38	20.92	59.29	0.62	0.65	1.02	5.0	10.37	1.24
1.2	8.0	11.9	6.03	0.51	31.06	18.96	56.56	0.62	0.66	1.04	5.0	-	-
1.3	8.0	11.8	6.22	0.50	31.29	19.66	57.67	0.65	0.68	1.04	5.1	3.37	0.83
1.4	7.9	11.8	6.12	0.50	30.17	19.91	56.57	0.67	0.68	1.02	5.0	3.01	0.51

SECCHI DISC DEPTH:(cm) 180

2.0	8.2	11.9	6.51	0.53	30.88	23.12	61.04	0.62	0.68	[illegible]	[illegible]	-	-
2.1	8.2	11.4	6.95	0.53	31.38	29.10	67.96	0.62	0.65	[illegible]	[illegible]	[illegible]	[illegible]
2.2	8.2	11.5	6.67	0.57	30.73	21.26	59.23	0.60	0.60	[illegible]	[illegible]	-	-
2.3	8.1	10.2	6.38	0.53	31.83	25.27	64.01	0.54	0.58	[illegible]	[illegible]	[illegible]	[illegible]
2.5	8.1	9.1	6.07	0.55	28.67	28.37	63.66	0.54	0.58	[illegible]	[illegible]	[illegible]	[illegible]
2.7	8.1	9.0	6.46	0.51	31.03	26.04	64.41	0.58	0.62	0.97	4.83	-	-
2.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2.11	8.0	8.8	6.47	0.51	30.88	25.15	63.01	0.66	0.68	1.08	4.03	-	-
2.13	8.0	8.8	6.75	0.53	31.56	23.93	62.77	0.66	0.68	1.08	3.92	-	-
2.16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-

SECCHI DISC DEPTH (cm) 130

3.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
3.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
3.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SECCHI DISC DEPTH (cm) 180

DATE: 08 12 '83

Samples Depth m	Temperature °C	Dissolved Oxygen mg $O_2.dm^{-3}$	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg $C.m^{-3}.h^{-1}$	Extracellular Carbon Release percent
1.0	5.8	11.8	4.33	0.47	35.17	9.30	49.17	0.69	0.75	1.29	4.80	-	-
1.1	5.8	11.8	4.41	0.49	36.38	7.81	48.59	0.69	0.83	1.38	3.90	6.39	0.61
1.2	5.8	11.8	4.32	0.49	36.16	9.37	50.22	0.69	0.74	1.37	3.90	-	-
1.3	5.8	11.8	4.33	0.48	34.31	9.58	49.31	0.69	0.72	1.28	3.70	2.92	0.21
1.4	5.8	11.8	4.37	0.51	35.42	8.77	48.37	0.72	0.70	1.33	3.50	1.14	0.10

SECCHI DISC DEPTH: (cm) 410

2.0	5.8	12.0	4.42	0.55	34.93	9.03	49.23	0.63	0.91	1.41	4.80	-	-
2.1	5.8	12.0	4.41	0.57	35.18	7.51	48.57	0.69	0.87	1.37	4.80	5.38	0.41
2.2	5.8	11.9	4.37	0.49	36.02	8.65	49.43	0.69	0.87	1.37	4.30	-	-
2.3	5.8	11.9	4.37	0.53	35.81	7.70	48.52	0.71	0.87	1.38	4.20	2.33	0.21
2.5	5.8	11.9	4.38	0.54	35.49	8.84	49.41	0.69	0.75	1.43	3.80	1.99	0.20
2.7	5.8	11.9	4.37	0.57	35.33	8.02	48.39	0.67	0.71	1.26	3.10	-	-
2.9	5.8	11.9	4.42	0.57	35.39	8.11	48.39	0.66	0.63	1.09	2.90	0.54	0.0
2.11	5.8	11.9	4.29	0.57	35.33	7.29	47.48	0.65	0.67	1.14	2.20	-	-
2.13	5.8	11.9	4.38	0.59	35.53	6.93	47.23	0.59	0.63	1.16	2.30	-	-
2.16	5.8	11.9	4.33	0.59	35.53	6.80	47.25	0.63	0.63	1.11	1.40	-	-

SECCHI DISC DEPTH (cm) 390

3.0	5.8	12.0	4.41	0.49	35.19	9.19	49.18	0.61	0.86	1.37	4.60	-	-
3.1	5.8	11.8	4.41	0.51	35.31	9.98	49.21	0.59	0.69	1.33	4.70	5.21	0.49
3.2	5.8	11.8	4.32	0.49	35.33	8.67	49.31	0.63	0.68	1.33	1.40	-	-
3.3	5.8	11.9	4.39	0.47	35.39	8.10	48.35	0.63	0.71	1.27	4.00	2.61	0.3
3.4	5.8	11.9	4.17	0.53	35.38	8.25	48.33	0.63	0.71	1.27	3.50	1.41	0.0

SECCHI DISC DEPTH (cm) 420

DATE: 01 04 '84

Kolmarden Depth m	Temperature °C	Dissolved Oxygen $mg\ O_2.dm^{-3}$	Ammonium μg at NH_3-$N.dm^{-3}$	Nitrite μg at NO_2^--$N.dm^{-3}$	Nitrate μg at NO_3^--$N.dm^{-3}$	Total Organic Nitrogen μg at $N.dm^{-3}$	Total Nitrogen μg at $N.dm^{-3}$	Soluble Reactive Phosphor μg at PO_4^{3-}-$P.dm^{-3}$	Total Dissolved Phosphor μg at $P.dm^{-3}$	Total Phosphor μg at $P.dm^{-3}$	Chlorophyll a $\mu g.dm^{-3}$	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release percent
1.0	6.3	12.8	1.08	0.21	62.17	9.71	63.17	0.67	0.87	1.39	6.10	-	-
1.1	6.2	12.8	0.96	0.22	69.12	5.86	76.16	0.59	0.69	1.28	6.00	30.19	2.83
1.2	6.2	12.7	0.98	0.22	63.14	12.87	77.21	0.63	0.73	1.37	6.20	-	-
1.3	6.1	12.7	0.86	0.21	66.19	8.91	76.17	0.65	0.71	1.29	6.00	10.08	1.06
1.4	5.9	12.7	1.02	0.19	59.81	14.40	75.42	0.72	0.82	1.31	5.90	6.07	0.58

SECCHI DISC DEPTH:(cm) 200

2.0	6.3	12.7	0.79	0.22	64.16	9.95	75.12	0.62	0.83	1.62	6.10	-	-
2.1	6.3	12.7	0.84	0.17	65.17	9.94	76.12	0.63	0.91	1.43	6.30	31.39	2.77
2.2	6.2	12.6	1.02	0.19	63.16	10.80	75.17	0.63	0.75	1.79	6.30	-	-
2.3	6.1	12.6	0.80	0.18	60.22	13.02	74.22	0.69	0.91	1.25	6.50	12.17	1.16
2.5	5.8	12.5	0.80	0.17	59.83	13.34	74.14	0.69	0.83	1.41	6.20	5.03	0.48
2.7	5.4	12.3	0.86	0.19	61.24	11.91	74.24	0.63	0.79	1.62	5.90	-	-
2.9	5.2	12.3	0.90	0.19	60.21	9.53	70.83	0.63	0.79	1.35	5.40	3.21	0.20
2.11	5.0	12.3	0.98	0.18	63.12	9.93	74.21	0.69	0.85	1.31	5.30	-	-
2.13	5.0	12.3	1.02	0.18	59.62	12.80	73.62	0.69	0.85	1.31	4.90	-	-
2.16	5.0	12.2	1.12	0.18	58.29	13.42	73.01	0.69	0.85	1.31	4.70	-	-

SECCHI DISC DEPTH (cm) 195

3.0	6.2	12.8	0.72	0.17	59.17	11.11	71.17	0.63	0.79	1.29	5.9	-	-
3.1	6.2	12.7	1.02	0.19	62.12	9.77	73.10	0.63	0.75	1.28	6.2	34.17	2.77
3.2	6.1	12.6	1.09	0.19	65.17	8.22	74.67	0.67	0.83	1.22	6.4	-	-
3.3	6.0	12.6	1.00	0.19	63.14	9.85	74.18	0.69	0.91	1.41	6.3	12.45	1.60
3.4	6.0	12.6	0.81	0.18	62.91	10.01	73.91	0.69	0.91	1.47	6.2	7.12	0.81

SECCHI DISC DEPTH (cm) 195

DATE: 17 04 '84

Sechiaas Depth m	Temperature °C	Dissolved Oxygen $mg.dm^{-3}$	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release percent
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	78.96	[illegible]	[illegible]	1.08	22.49	-	-
1.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.13	75.86	[illegible]	[illegible]	1.12	21.60	81.97	5.85
1.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	76.53	[illegible]	[illegible]	1.82	20.12	-	-
1.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73.96	[illegible]	[illegible]	1.16	20.42	79.41	5.66
1.6	8.4	[illegible]	[illegible]	[illegible]	58.53	14.62	74.43	[illegible]	[illegible]	1.54	20.12	77.42	5.53

SECCHI DISC DEPTH:(cm) 140

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17.95	77.91	[illegible]	[illegible]	1.25	21.01	-	-
2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22.45	[illegible]	[illegible]	[illegible]	1.45	20.72	87.79	5.10
2.2	[illegible]	[illegible]	[illegible]	[illegible]	59.54	21.45	[illegible]	[illegible]	[illegible]	1.79	21.16	-	-
2.4	[illegible]	[illegible]	[illegible]	[illegible]	56.87	22.18	[illegible]	[illegible]	[illegible]	1.82	20.64	53.16	7.98
2.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.29	[illegible]	[illegible]	[illegible]	[illegible]	17.12	8.97	1.55
2.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.36	[illegible]	[illegible]	[illegible]	[illegible]	11.12	-	-
3.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.96	[illegible]	[illegible]	[illegible]	[illegible]	7.32	3.34	1.82
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.24	-	-
3.17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.16	-	-
3.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	47.45	[illegible]	[illegible]	[illegible]	7.21	-	-

SECCHI DISC DEPTH (cm) 140

3.0	7.0	12.4	0.76	0.16	47.74	13.43	62.09	0.66	[illegible]	1.20	17.45	-	-
3.1	[illegible]	[illegible]	1.16	0.20	[illegible]	16.22	65.32	0.66	[illegible]	1.28	15.08	88.12	6.36
3.2	7.0	11.4	1.32	0.20	[illegible]	[illegible]	67.61	0.63	[illegible]	1.28	16.87	-	-
3.3	[illegible]	[illegible]	[illegible]	0.20	47.74	14.31	[illegible]	0.66	0.83	[illegible]	18.35	78.30	5.19
3.4	7.0	11.7	[illegible]	0.18	[illegible]	14.82	65.78	0.66	0.87	1.33	16.87	32.47	4.68

SECCHI DISC DEPTH (cm) 150

DATE: 10 05 '84

Station Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2-N.dm^{-3}	Nitrate µg at NO_3-N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	11.1	12.0	0.96	0.24	59.71	9.29	70.20	0.33	0.66	1.04	9.76	-	-
1.1	11.1	11.8	0.64	0.18	58.70	18.59	78.11	0.33	0.83	1.04	11.16	46.23	4.94
1.2	11.1	10.2	0.72	0.18	59.31	17.57	78.25	0.33	0.66	0.83	8.75	-	-
1.3	11.0	9.40	1.00	0.20	62.36	21.91	75.19	0.29	0.45	1.08	8.25	14.14	2.11
1.4	11.0	9.50	1.04	0.20	56.00	13.39	71.23	0.29	0.20	0.91	9.01	7.62	0.94

SECCHI DISC DEPTH: (cm) 100

2.0	11.3	10.4	.88	.18	60.36	15.30	74.36	.33	0.75	0.91	5.28	-	-
2.1	11.2	10.9	0.64	.24	59.28	4.59	72.25	.41	0.87	0.95	3.31	18.40	5.68
2.2	11.1	10.8	0.88	.20	59.17	4.59	71.49	.41	.75	0.83	4.36	-	-
2.3	11.0	10.7	0.88	.26	58.1	3.17	80.03	.41	0.66	.83	3.47	21.49	5.18
2.5	10.8	10.5	0.92	.18	59.14	10.41	3.45	.41	0.66	.79	5.12	1.81	0.75
2.7	10.6	10.3	0.84	.20	58.28	4.72	72.41	.41	0.87	1.08	8.47	-	-
2.9	10.4	10.0	1.68	.24	61.31	11.15	84.48	.37	0.87	0.91	3.16	4.19	0.72
2.11	9.2	8.3	4.53	.24	12.17	6.30	83.24	0.45	0.83	.91	0.10	-	-
2.13	8.8	7.9	3.94	.20	14.53	14.36	58.30	0.45	0.83	0.91	6.54	-	-
2.16	8.5	7.4	6.26	0.20	8.20	16.92	52.84	0.37	0.83	0.91	5.23	-	-

SECCHI DISC DEPTH (cm) 110

3.0	11.0	12.4	0.80	1.10	59.10	9.03	68.83	0.33	0.75	1.04	8.57	-	-
3.1	10.8	11.4	0.52	1.10	59.72	11.17	70.31	0.33	1.00	1.12	9.47	38.68	5.27
3.2	10.4	11.2	0.68	1.10	54.31	14.73	70.32	0.50	1.00	0.87	8.01	-	-
3.3	10.2	11.1	0.68	1.10	58.18	9.31	68.77	0.37	0.90	0.87	8.07	9.89	1.28
3.4	10.0	11.2	0.68	1.10	57.82	10.19	68.78	0.37	0.87	0.87	9.01	4.58	0.69

SECCHI DISC DEPTH (cm) 150

DATE: 25 05 '84

Zone/Trans Depth m	Temperature °C	Dissolved Oxygen $mg\ O_2.dm^{-3}$	Ammonium μg at NH_3-$N.dm^{-3}$	Nitrite μg at NO_2^--$N.dm^{-3}$	Nitrate μg at NO_3^--$N.dm^{-3}$	Total Organic Nitrogen μg at $N.dm^{-3}$	Total Nitrogen μg at $N.dm^{-3}$	Soluble Reactive Phosphor μg at PO_4^{2-}-$P.dm^{-3}$	Total Dissolved Phosphor μg at $P.dm^{-3}$	Total Phosphor μg at $P.dm^{-3}$	Chlorophyll a $\mu g.dm^{-3}$	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release Percent
1.0	10.8	10.8	0.96	0.26	32.22	18.30	51.74	0.75	1.08	1.41	10.06	-	-
1.1	11.6	10.6	1.28	0.28	32.61	19.42	53.32	0.82	1.54	1.66	9.47	56.36	5.05
1.2	11.5	10.4	1.52	0.28	31.68	19.48	52.35	0.82	1.54	1.66	8.69	-	-
1.3	10.5	10.6	1.28	0.30	33.11	20.08	53.86	0.82	1.54	1.66	11.24	24.66	2.08
1.4	10.3	10.5	1.20	0.24	33.42	21.21	54.65	0.75	1.04	1.69	9.28	11.27	0.90

SECCHI DISC DEPTH: (cm) 130

2.0	12.0	11.2	0.88	0.32	32.61	18.78	52.59	0.75	1.12	1.37	12.13	-	-
2.1	12.0	11.2	1.00	0.28	31.82	19.42	52.42	0.75	1.16	1.37	12.43	54.92	5.72
2.2	12.0	11.2	1.24	0.28	32.71	19.48	53.51	0.75	1.25	1.50	14.80	-	-
2.3	12.0	11.2	0.80	0.26	32.38	20.08	54.12	0.70	1.00	1.66	16.57	21.22	3.07
2.5	11.3	11.0	1.04	0.28	34.11	21.21	56.64	0.70	1.00	1.37	9.65	6.10	0.68
2.7	11.2	10.4	1.28	0.26	35.71	23.19	60.44	0.70	1.00	1.50	9.24	-	-
2.9	11.1	10.1	1.08	0.32	31.80	24.17	57.37	0.70	1.00	1.37	8.58	4.48	0.37
2.11	10.6	10.0	1.12	0.30	30.01	27.15	49.18	0.83	1.12	1.66	7.23	-	-
2.13	9.8	9.4	2.04	0.30	13.02	58.16	59.52	0.83	1.20	1.66	6.19	-	-
2.16	9.8	9.0	2.18	0.30	12.59	45.27	60.13	0.87	1.25	1.66	6.17	-	-

SECCHI DISC DEPTH (cm) 120

3.0	11.8	11.8	0.96	0.32	32.90	19.17	53.35	0.83	0.87	1.37	10.66	-	-
3.1	11.5	11.0	0.84	0.28	32.80	20.08	54.00	0.70	0.87	1.37	13.02	55.64	4.60
3.2	11.0	10.7	0.84	0.28	32.73	19.83	53.67	0.73	0.85	1.37	11.84	21.04	2.58
3.3	10.7	10.4	1.56	0.26	33.37	19.83	55.02	0.89	1.04	1.29	9.76	-	-
3.4	10.0	10.0	2.44	0.28	32.98	20.70	56.40	0.89	1.12	1.45	9.47	4.31	0.74

SECCHI DISC DEPTH (cm) 120

DATE: 07 06 '84

Station Depth m	Temperature °C	Dissolved Oxygen mg $O_2.dm^{-3}$	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	13.0	11.8	0.80	0.22	13.80	64.94	79.76	0.58	0.62	0.91	13.17	-	-
1.1	13.0	11.8	0.68	0.16	10.83	68.71	80.38	0.58	0.66	1.29	13.29	82.36	4.45
1.2	13.0	11.9	0.76	0.32	12.30	68.05	81.43	0.62	0.66	0.95	12.43	-	-
1.3	13.0	11.2	0.84	0.26	13.49	68.49	83.08	0.50	1.04	1.08	14.07	29.47	2.58
1.4	12.9	10.8	1.00	0.28	13.58	71.33	86.19	0.58	0.70	1.08	14.23	12.47	1.71

SECCHI DISC DEPTH:(cm) 130

2.0	13.2	11.8	0.60	0.22	11.10	72.81	84.73	0.58	0.66	1.20	13.02	-	-
2.1	13.1	11.8	0.64	0.16	11.10	70.97	82.87	0.75	0.91	1.20	14.23	81.17	4.37
2.2	13.1	11.8	0.64	0.26	11.22	74.28	86.40	0.75	0.75	1.25	14.73	-	-
2.3	13.1	11.8	0.64	0.20	11.64	72.06	84.54	0.62	1.08	1.25	14.91	31.13	2.61
2.5	13.1	11.8	0.68	0.26	11.27	74.21	86.42	0.58	0.95	1.25	14.02	11.73	2.08
2.7	13.0	11.8	0.68	0.22	11.10	74.18	86.18	0.54	0.70	0.95	13.27	-	-
2.9	12.0	7.5	1.88	0.24	11.39	69.50	83.70	0.50	0.83	0.95	9.33	4.26	0.50
2.11	10.4	4.9	2.57	0.22	10.70	75.73	89.22	0.41	0.80	0.98	7.21	-	-
2.13	10.0	4.8	4.45	0.26	8.30	84.03	97.04	0.41	0.81	1.06	6.03	-	-
2.16	9.8	4.1	8.47	0.30	6.70	92.12	99.12	0.40	0.79	1.04	5.81	-	-

SECCHI DISC DEPTH (cm) 130

3.0	13.0	11.8	0.52	0.20	11.25	68.81	80.78	0.66	0.62	1.08	13.17	-	-
3.1	13.0	11.8	0.52	0.26	11.25	71.69	83.72	0.66	0.79	1.06	14.22	79.16	5.84
3.2	12.9	11.9	0.52	0.18	10.52	72.08	83.30	0.66	0.75	1.08	14.17	-	-
3.3	11.6	11.2	0.52	0.14	11.69	73.82	86.17	0.54	1.06	1.33	15.25	30.01	2.51
3.4	11.0	10.8	1.08	0.14	13.24	75.92	89.82	1.00	1.08	1.33	15.02	10.17	1.53

SECCHI DISC DEPTH (cm) 130

DATE 26 06 '84

STATION Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	17.	9.3	[illegible]	0.26	40.75	61.86	104.35	0.54	0.70	0.95	16.15	-	-
1.1	17.	9.3	1.40	0.24	16.71	69.30	87.65	0.88	0.98	2.29	17.83	179.98	7.37
1.2	17.	9.0	[illegible]	0.26	18.01	89.35	89.35	0.50	0.84	1.75	17.25	-	-
1.3	17.	9.2	[illegible]	0.28	16.36	68.54	87.82	0.81	0.95	1.17	17.02	34.17	2.68
1.4	17.	9.1	[illegible]	0.32	22.57	73.32	97.27	0.65	0.80	2.33	15.25	11.10	1.33

SECCHI DISC DEPTH (cm 180

2.0	17.9	9.9	[illegible]	0.24	35.50	60.41	97.67	0.45	0.50	0.87	16.01	-	-
2.1	17.9	9.9	1.32	0.22	28.34	59.02	84.90	0.62	0.60	1.04	17.93	190.12	7.61
2.2	17.3	9.9	[illegible]	0.20	28.34	58.25	83.28	0.75	0.87	1.08	16.91	-	-
2.3	17.3	9.9	1.52	0.18	26.[illegible]	67.56	96.37	0.75	0.89	1.50	16.98	35.19	2.67
2.5	[illegible]	9.[illegible]	[illegible]	[illegible]	27.31	60.38	83.51	0.87	0.89	1.87	17.02	10.12	1.21
2.7	16.1	9.0	2.44	0.20	26.28	82.11	111.03	0.58	0.64	0.95	16.1	-	-
2.9	13.0	8.0	[illegible]	0.32	23.[illegible]	71.80	98.16	0.41	0.59	0.88	14.22	3.17	0.41
2.11	11.2	2.5	5.42	0.34	19.34	82.09	107.69	0.45	0.50	0.75	9.83	-	-
2.13	11.0	2.0	5.42	0.47	[illegible]	87.33	111.03	0.37	0.58	0.78	8.75	-	-
2.15	[illegible]	[illegible]	[illegible]	0.47	[illegible]	87.35	126.35	0.37	0.80	0.79	7.01	-	-

SECCHI DISC DEPTH (cm) 180

3.0	[illegible]	9.1	1.84	0.12	36.27	60.24	98.47	0.54	1.25	1.38	[illegible]	-	-
3.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70.65	107.06	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.2	17.1	9.1	1.14	0.18	33.90	62.73	97.65	0.54	0.61	0.95	17.32	-	-
3.3	17.1	9.1	1.42	0.22	29.29	64.01	94.94	0.66	0.65	0.91	17.33	32.11	2.76
3.4	17.1	9.0	2.44	0.26	26.89	75.59	105.18	0.55	0.82	1.15	15.19	4.24	1.31

SECCHI DISC DEPTH (cm) 180

DATE: 10 07 '84

Station Depth m	Temperature °C	Dissolved Oxygen $mg\ O_2.dm^{-3}$	Ammonium μg at NH_3-N.dm^{-3}	Nitrite μg at NO_2^--N.dm^{-3}	Nitrate μg at NO_3^--N.dm^{-3}	Total Organic Nitrogen μg at N.dm^{-3}	Total Nitrogen μg at N.dm^{-3}	Soluble Reactive Phosphor μg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor μg at P.dm^{-3}	Total Phosphor μg at P.dm^{-3}	Chlorophyll a $\mu g.dm^{-3}$	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release percent
1.0	22.5	8.1	2.04	0.44	36.33	69.46	108.27	0.45	0.62	0.83	6.31	-	-
1.1	21.1	7.8	1.56	0.46	30.82	73.64	106.48	0.50	0.50	1.04	7.10	68.17	5.93
1.2	18.0	9.1	2.20	0.42	35.64	69.45	107.71	0.58	0.70	1.00	9.54	-	-
1.3	17.8	9.1	2.20	0.42	36.43	70.12	109.17	0.58	0.70	1.58	13.06	71.62	9.87
1.4	17.0	8.5	1.48	0.38	36.92	72.34	111.12	0.45	0.50	1.20	9.94	35.52	4.12

SECCHI DISC DEPTH (cm) 235

2.0	22.3	8.0	1.32	0.50	36.43	72.87	111.12	0.37	0.45	0.95	8.28	-	-
2.1	22.0	6.8	1.12	0.50	36.55	72.24	110.41	0.37	0.79	0.83	7.89	82.41	8.15
2.2	21.5	6.9	1.36	0.52	30.69	75.60	108.17	0.37	0.66	0.83	7.10	-	-
2.3	19.0	8.0	1.72	0.44	38.30	66.05	106.41	0.50	0.58	1.33	14.99	124.70	16.03
2.5	16.0	8.0	2.55	0.46	39.38	63.70	106.59	0.50	0.50	1.29	10.41	30.50	3.01
2.7	15.2	5.0	2.93	0.50	30.06	82.47	107.48	0.37	0.54	0.87	8.28	-	-
2.9	13.0	1.7	4.45	0.98	16.83	86.45	108.41	0.37	0.45	0.75	3.94	3.42	0.33
2.11	12.0	0.75	9.95	0.77	11.71	86.36	108.79	0.37	0.66	0.70	2.76	-	-
2.13	11.4	0.25	12.43	0.79	10.52	90.55	114.29	0.37	0.45	0.87	2.76	-	-
2.16	11.1	0.25	14.69	0.98	10.01	94.19	120.17	0.37	1.04	1.04	2.76	-	-

SECCHI DISC DEPTH (cm) 280

3.0	23.5	7.8	1.36	0.42	40.67	66.01	108.46	0.50	0.62	1.04	7.10	-	-
3.1	23.5	7.4	1.36	0.50	36.23	71.08	109.17	0.50	0.50	1.08	7.49	106.6	10.05
3.2	21.5	7.4	1.24	0.46	36.23	71.23	109.16	0.45	0.62	1.00	9.47	-	-
3.3	21.5	7.8	1.04	0.50	36.14	64.69	102.37	0.45	0.54	1.54	10.26	80.23	7.99
3.4	19.4	7.6	4.01	0.52	32.49	71.39	108.41	0.66	0.83	1.79	9.82	25.37	2.10

SECCHI DISC DEPTH (cm) 210

DATE: 26 07 '84

Kongsøs Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	19.5	8.3	1.56	0.38	32.30	62.39	96.63	0.50	0.66	1.29	8.87	-	-
1.1	19.5	8.2	2.76	0.44	29.42	66.48	98.70	0.50	0.50	1.25	8.68	56.42	4.08
1.2	19.5	8.5	2.6	0.40	31.42	62.62	97.04	0.54	0.91	1.16	8.09	-	-
1.3	19.0	8.8	1.80	0.34	31.33	77.25	110.82	0.50	0.83	1.20	8.10	8.23	1.21
1.4	17.5	6.6	2.69	0.58	30.81	60.42	94.50	0.66	1.00	1.25	8.10	5.57	0.80

SECCHI DISC DEPTH:(cm) 180

2.0	19.3	9.4	1.12	0.46	29.37	71.52	102.47	0.30	0.87	1.04	9.07	-	-
2.1	19.2	9.3	2.24	0.42	31.42	69.02	103.10	0.30	0.54	1.04	8.47	112.49	4.83
2.2	19.0	9.1	1.60	0.44	30.93	64.07	97.04	0.30	0.54	0.95	8.39	-	-
2.3	19.0	9.1	1.60	0.40	30.87	70.64	103.51	0.31	0.66	0.79	8.27	31.73	2.68
2.5	17.0	6.7	1.83	0.40	30.79	62.14	95.16	0.30	0.79	0.87	8.01	15.11	1.92
2.7	17.0	3.8	5.10	0.38	29.52	73.10	108.10	0.30	0.75	0.79	7.32	-	-
2.9	14.0	0.2	8.95	1.08	8.39	81.75	100.17	0.30	0.50	0.93	4.91	3.40	0.66
2.11	12.1	0.1	16.06	1.03	2.53	91.20	110.82	0.29	0.66	0.79	3.95	-	-
2.13	11.1	0.1	25.30	1.25	1.37	96.60	124.52	0.29	0.79	1.12	3.91	-	-
2.16	11.0	0.1	25.06	2.77	0.99	108.64	137.46	0.29	0.58	1.50	3.86	-	-

SECCHI DISC DEPTH (cm) 190

3.0	19.0	8.8	1.80	0.40	30.32	84.77	117.29	0.41	0.66	1.25	8.82	-	-
3.1	18.8	8.5	1.44	0.48	31.37	68.14	101.43	0.41	0.54	1.20	8.71	176.81	6.73
3.2	18.2	8.5	1.56	0.54	29.38	70.81	102.89	0.45	0.62	1.50	8.91	-	-
3.3	18.0	7.1	1.64	0.50	28.73	71.39	102.26	0.41	0.58	1.54	8.73	20.74	2.19
3.4	17.5	6.5	2.24	0.58	30.41	68.79	102.02	0.41	0.70	1.16	8.52	7.32	1.05

SECCHI DISC DEPTH (cm) 190

DATE: 09 08 '84

Station Depth m	Temperature °C	Dissolved Oxygen $mg\ O_2.dm^{-3}$	Ammonium μg at NH_3-N.dm^{-3}	Nitrite μg at NO_2^--N.dm^{-3}	Nitrate μg at NO_3^--N.dm^{-3}	Total Organic Nitrogen μg at N.dm^{-3}	Total Nitrogen μg at N.dm^{-3}	Soluble Reactive Phosphor μg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor μg at P.dm^{-3}	Total Phosphor μg at P.dm^{-3}	Chlorophyll a $\mu g.dm^{-3}$	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release percent
1.0	20.0	8.9	2.08	0.42	28.40	80.27	111.17	0.62	0.79	1.04	10.3	-	-
1.1	19.9	9.0	2.73	0.42	27.91	92.89	123.95	0.70	0.70	1.25	13.02	44.17	10.96
1.2	19.8	9.0	2.16	0.42	25.21	96.62	124.41	0.62	0.71	1.20	11.69	-	-
1.3	19.8	9.0	2.32	0.44	27.52	92.94	123.22	0.70	0.73	1.58	15.54	42.49	3.87
1.4	19.8	8.8	2.57	0.48	24.76	100.41	128.22	0.60	1.00	1.12	10.65	16.72	1.96

SECCHI DISC DEPTH:(cm) 185

2.0	19.0	9.1	2.97	0.48	24.14	81.58	109.17	0.60	0.71	0.87	14.80	-	-
2.1	19.0	9.1	3.41	0.48	23.38	84.15	111.42	0.60	0.71	1.45	10.65	146.88	7.99
2.2	19.0	8.8	4.37	0.46	26.01	77.70	108.54	0.62	0.70	1.20	11.39	-	-
2.3	18.9	8.2	3.26	0.46	24.83	98.80	127.35	0.60	0.70	1.08	13.76	64.36	5.49
2.5	18.4	7.0	3.89	0.44	19.15	88.50	122.98	0.60	0.69	1.04	14.35	12.11	1.26
2.7	17.0	5.4	21.60	0.16	10.12	91.37	123.25	0.64	0.68	2.45	5.92	-	-
2.9	14.9	2.9	22.32	0.20	6.40	99.35	128.27	0.60	0.58	0.95	5.47	5.65	0.44
2.11	12.3	0.2	18.40	0.14	2.26	108.42	129.22	0.60	0.52	1.04	5.48	-	-
2.13	12.0	0.0	33.61	0.10	0.98	102.77	137.46	1.50	1.41	1.95	5.47	-	-
2.16	11.2	0.0	36.12	0.70	0.88	111.19	148.29	1.88	1.80	2.70	5.47	-	-

SECCHI DISC DEPTH (cm) 185

3.0	19.7	9.0	2.04	0.48	29.83	56.01	112.28	0.62	0.70	0.91	15.20	-	-
3.1	19.5	9.0	2.28	0.48	24.91	61.08	119.31	0.62	0.70	1.12	12.36	148.93	7.93
3.2	19.5	9.0	3.05	0.38	30.23	61.23	121.45	0.62	0.70	1.00	17.3	-	-
3.3	19.5	8.9	2.16	0.46	25.60	54.49	128.22	0.75	0.70	1.12	15.34	34.26	3.59
3.4	19.0	8.9	3.29	0.38	24.91	61.39	129.00	0.66	0.79	1.12	15.54	13.27	1.68

SECCHI DISC DEPTH (cm) 170

DATE: 23 08 '84

Station no. Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}*	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	21.0	8.3	1.84	0.46	22.52	111.04	135.86	0.87	0.40	7.87	11.69	-	-
1.1	21.0	8.4	1.20	0.46	23.43	108.06	133.15	0.87	0.90	7.41	13.32	214.14	17.66
1.2	20.4	8.4	0.84	0.46	23.38	105.72	130.44	0.83	0.45	8.08	11.54	-	-
1.3	20.4	8.4	0.88	0.44	22.94	113.90	138.16	0.83	1.16	7.54	13.41	80.04	9.44
1.4	20.4	8.2	1.20	0.42	21.83	113.04	136.49	0.83	0.83	7.54	12.12	44.50	3.32

SECCHI DISC DEPTH: (cm) 185

2.0	20.0	8.2	1.08	0.42	22.67	117.12	141.29	1.00	1.45	7.66	12.13	-	-
2.1	19.4	8.2	1.17	0.24	17.05	100.75	120.00	0.75	1.04	7.66	10.55	248.58	17.25
2.2	19.5	8.6	1.17	0.46	24.07	92.21	117.91	0.83	0.84	2.50	13.46	-	-
2.3	19.2	8.4	1.37	0.24	23.70	120.15	145.46	0.83	0.88	2.12	13.61	74.58	9.28
2.5	17.8	5.0	2.40	0.20	22.20	112.73	137.53	0.83	0.83	2.08	13.62	33.06	2.91
2.7	15.2	2.5	8.27	0.20	20.35	120.19	149.01	0.83	0.89	1.79	5.03	-	-
2.9	14.0	0.0	11.16	0.24	1.94	141.51	154.85	0.83	0.89	2.16	4.50	10.28	0.98
2.11	12.3	0.0	29.91	0.14	0.71	136.41	167.17	1.04	0.99	8.50	4.20	-	-
2.13	12.0	0.0	37.35	0.14	0.56	151.20	189.71	2.95	6.99	11.60	4.10	-	-
2.16	11.2	0.0	38.59	0.14	0.76	152.10	191.59	5.16	8.32	15.50	3.98	-	-

SECCHI DISC DEPTH (cm) 185

3.0	21.3	8.4	1.12	0.38	23.68	111.73	136.91	0.79	1.85	7.58	13.32	-	-
3.1	21.3	7.8	0.84	0.42	23.68	110.09	135.03	0.83	2.45	7.75	12.35	235.81	18.12
3.2	21.1	7.3	1.08	0.40	23.45	108.43	133.36	0.83	1.54	7.75	12.48	-	-
3.4	21.1	7.7	1.29	0.38	23.08	106.73	131.48	1.25	1.58	14.62	14.33	44.21	3.35

SECCHI DISC DEPTH (cm) 190

DATE: 08 09 '84

Station Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release
1.0	14.8	8.4	4.97	0.36	17.30	35.11	57.74	0.91	0.66	1.12	10.50	-	-
1.1	16.8	7.2	5.02	0.42	14.64	36.41	56.49	0.70	0.75	1.16	8.88	18.84	2.17
1.2	16.8	7.1	4.97	0.40	17.01	40.16	62.54	0.70	0.75	1.16	8.76	-	-
1.3	16.8	7.1	5.54	0.36	15.21	38.93	60.04	0.62	0.75	1.12	8.12	7.23	0.33
1.4	16.0	7.0	4.53	0.34	16.29	43.85	65.01	0.62	0.83	1.12	8.14	7.50	0.34

SECCHI DISC DEPTH: (cm) 195

2.0	16.4	8.0	5.82	0.36	15.18	40.54	61.70	0.62	0.66	1.12	8.8	-	-
2.1	16.4	7.8	6.06	0.36	15.41	39.03	61.46	0.62	0.75	1.16	8.38	14.84	1.22
2.2	16.4	7.8	5.82	0.36	15.53	48.45	70.16	0.62	0.66	1.16	8.54	-	-
2.4	16.2	7.8	5.50	0.36	15.03	45.22	66.79	0.62	0.70	1.08	8.20	3.40	0.4
2.5	16.2	7.8	5.58	0.32	14.52	46.57	66.79	0.62	0.75	1.12	7.95	7.08	0.2
2.7	16.2	7.8	5.94	0.42	8.54	44.81	59.81	0.62	0.78	1.16	8.30	-	-
2.9	15.6	-	6.98	0.42	8.82	47.15	62.35	0.62	0.75	1.12	8.20	7.08	-
3.11	12.8	10.4	21.13	0.20	8.09	45.30	76.72	1.08	0.83	1.16	4.79	-	-
3.13	12.8	9.8	28.39	0.14	8.06	55.20	86.48	3.54	3.70	4.12	4.44	-	-
3.15	12.6	9.5	29.15	0.14	8.81	101.34	133.14	5.16	5.70	5.70	3.55	-	-

SECCHI DISC DEPTH (cm) 200

3.0	12.0	10.8	6.98	0.42	17.69	37.61	62.70	0.62	0.66	1.08	9.12	-	-
3.1	15.0	7.2	4.16	0.44	15.73	45.57	65.90	0.62	0.70	1.12	8.28	12.55	1.98
3.2	15.8	8.0	1.85	0.44	17.10	43.64	66.03	0.64	0.75	1.16	9.47	-	-
3.3	16.0	7.1	7.18	0.40	16.59	38.52	62.69	0.64	3.04	3.50	8.62	2.34	0.71
3.4	16.0	7.0	10.52	0.44	16.90	41.34	69.80	0.79	2.62	3.70	8.28	2.10	0.30

SECCHI DISC DEPTH (cm) 200

DATE: 25 09 '84

Monitoring depth m	Temperature °C	Dissolved Oxygen $mg\ O_2.dm^{-3}$	Ammonium $\mu g\ at\ NH_3\text{-}N.dm^{-3}$	Nitrite $\mu g\ at\ NO_2\text{-}N.dm^{-3}$	Nitrate $\mu g\ at\ NO_3\text{-}N.dm^{-3}$	Total Inorganic Nitrogen $\mu g\ at\ N.dm^{-3}$	Total Nitrogen $\mu g\ at\ N.dm^{-3}$	Soluble Reactive Phosphor $\mu g\ at\ PO_4\text{-}P.dm^{-3}$	Total Dissolved Phosphor $\mu g\ at\ P.dm^{-3}$	Total Phosphor $\mu g\ at\ P.dm^{-3}$	Chlorophyll a $\mu g.dm^{-3}$	Primary Production $mg\ C.m^{-3}.h^{-1}$	Extracellular Carbon Release percent
1.0	12.4	9.1	0.28	0.34	42.76	43.38	74.76	0.65	2.50	2.90	7.10	-	-
1.1	12.4	9.1	0.28	0.34	42.76	43.38	69.37	0.79	6.80	8.10	6.90	43.71	5.43
1.2	12.4	9.1	0.28	0.34	42.76	43.38	70.14	0.45	8.96	2.30	6.80	-	-
1.3	12.4	9.1	0.28	0.34	42.76	43.38	71.04	0.58	4.24	9.99	8.50	7.61	1.12
1.4	12.4	9.1	0.28	0.34	42.76	43.38	62.12	0.58	3.56	11.10	5.70	5.41	0.96

SECCHI DISC DEPTH (cm) 210

2.0	12.4	9.1	0.28	0.34	42.76	43.38	69.37	0.79	1.35	2.80	2.40	-	-
2.1	12.4	9.1	0.28	0.34	42.76	43.38	70.14	0.45	0.78	3.21	7.20	25.43	4.33
2.2	12.4	9.1	0.28	0.34	42.76	43.38	71.04	0.58	2.87	3.31	6.80	-	-
2.3	12.4	9.1	0.28	0.34	42.76	43.38	62.12	0.58	3.56	7.54	9.30	7.31	1.24
2.4	12.4	9.1	0.28	0.34	42.76	43.38	69.37	0.79	1.35	4.10	5.40	5.41	1.11
2.5	12.4	9.1	0.28	0.34	42.76	43.38	70.14	0.45	0.78	4.30	5.40	-	-
2.9	12.4	9.1	0.28	0.34	42.76	43.38	71.04	0.58	3.71	4.10	6.00	6.06	1.03
2.11	12.4	9.1	0.28	0.34	16.49	36.74	60.04	0.50	3.94	5.10	4.50	-	-
2.13	12.4	9.1	0.28	0.34	42.76	43.38	73.62	0.50	13.5	22.15	4.41	-	-
2.15	12.4	9.1	0.28	0.34	42.76	43.38	58.92	0.50	24.25	39.11	4.59	-	-

SECCHI DISC DEPTH (cm) 200

3.0	12.2	10.3	0.24	0.45	0.45	51.32	15.25	0.41	0.62	2.17	3.0	-	-
3.1	12.2	10.3	0.24	0.45	12.43	42.27	81.00	0.45	0.62	2.16	6.4	36.82	5.66
3.2	12.0	10.2	0.24	0.56	20.08	35.86	82.04	0.45	0.83	2.10	6.3	-	-
3.3	12.0	10.4	1.37	0.46	15.51	10.30	82.24	0.50	1.33	2.08	6.0	6.84	1.15
3.4	11.8	10.0	4.58	0.46	20.16	42.32	87.49	0.41	1.04	2.43	5.6	2.98	0.52

SECCHI DISC DEPTH (cm) 300

DATE. 03 06 '83

Sample Depth m	Temperature °C	Dissolved Oxygen mg $O_2.dm^{-3}$	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{-3}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
1.0	14.1	9.2	1.12	0.22	19.83	14.89	36.08	0.48	0.61	0.97	11.92	-	-
1.1	14.1	9.2	0.99	0.24	20.87	14.91	36.99	0.79	0.93	1.09	11.79	77.17	9.83
1.2	13.4	9.2	1.00	0.25	20.74	14.91	37.01	0.90	1.02	1.22	12.01	-	-
1.3	13.1	9.2	1.12	0.25	21.74	14.71	37.82	0.87	0.99	1.27	10.87	27.74	3.03
1.4	13.5	9.0	1.22	0.25	21.82	15.00	38.29	0.91	1.04	1.30	10.22	10.04	1.08

SECCHI DISC DEPTH:(cm) 140

2.0	14.1	9.3	0.92	0.20	20.90	14.47	36.49	0.55	0.83	0.99	10.32	-	-
2.1	14.4	9.3	0.94	0.22	21.76	14.25	37.17	0.60	0.77	0.87	12.47	34.10	8.75
2.2	14.1	9.2	1.03	0.22	21.82	14.32	37.39	0.71	0.96	1.09	12.27	-	-
2.3	13.8	9.1	1.28	0.25	20.90	14.64	37.07	0.69	0.89	1.06	11.42	31.16	2.91
2.5	13.6	9.1	1.30	0.23	21.80	14.69	38.02	0.72	0.92	1.17	10.71	11.72	1.09
2.7	13.3	8.8	1.31	0.22	21.29	14.30	37.12	0.59	0.87	1.12	10.12	-	-
2.9	13.0	8.4	2.09	0.24	21.17	14.79	38.29	0.57	0.80	1.09	9.80	3.91	0.39
2.11	11.2	5.0	2.97	0.26	20.99	14.79	39.01	0.54	0.83	1.07	9.81	-	-
2.13	8.7	4.8	4.79	0.29	21.82	12.34	39.24	0.49	0.69	1.00	6.92	-	-
2.16	8.2	4.8	4.89	0.39	21.99	13.71	40.98	0.45	0.70	0.92	7.16	-	-

SECCHI DISC DEPTH (cm) 130

3.0	14.1	9.2	0.99	0.23	21.24	14.75	37.21	0.59	0.69	0.96	12.15	-	-
3.1	14.1	9.2	1.04	0.25	21.09	14.53	36.91	0.81	0.89	1.09	12.91	79.12	7.65
3.2	14.0	8.9	1.07	0.25	20.13	15.09	36.54	0.77	0.89	1.12	11.49	-	-
3.3	13.8	9.1	1.09	0.27	21.01	14.56	36.93	0.70	1.01	1.40	11.39	29.17	3.81
3.4	13.8	9.1	1.27	0.27	22.07	14.56	38.17	0.79	0.91	1.19	11.41	10.01	1.03

SECCHI DISC DEPTH (cm) 130

NORRÄS Depth m	Temperature °C	Dissolved Oxygen $mg\ O_2 \cdot dm^{-3}$	Ammonium $\mu g\ at\ NH_4\text{-}N \cdot dm^{-3}$	[illegible] $\mu g\ at\ NO_3\text{-}N \cdot dm^{-3}$	[illegible] $\mu g\ at\ NO_2\text{-}N \cdot dm^{-3}$	[illegible] $\mu g\ at\ P \cdot dm^{-3}$	[illegible] $\mu g\ at\ N \cdot dm^{-3}$	Organic Carbon $\mu g\ at\ C \cdot dm^{-3}$	[illegible] $\mu g\ at\ N \cdot dm^{-3}$	[illegible] $\mu g\ at\ C \cdot dm^{-3}$	[illegible] $\mu g\ at\ C \cdot dm^{-3}$	[illegible] $\mu g\ at\ C \cdot dm^{-3}$	Extracellular Carbon Release percent
2.0	10.8	10.1	1.65	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]	[illegible]	7.16	[illegible]	-	-
2.1	10.8	9.9	2.15	[illegible]	4.8[illegible]	[illegible]	[illegible]	1.[illegible]	[illegible]	7.[illegible]	[illegible]	14.1[illegible]	1.[illegible]
2.2	10.8	9.9	2.16	11.54	[illegible]	[illegible]	[illegible]	1.[illegible]	[illegible]	[illegible]	[illegible]	-	-
2.3	10.8	9.9	2.20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.47	[illegible]	[illegible]	[illegible]
2.5	10.8	9.8	2.17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.57	[illegible]	[illegible]	[illegible]
2.7	10.8	9.8	1.84	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
2.9	10.8	9.8	1.88	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.11	10.8	9.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
3.13	10.8	9.8	2.48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-
3.16	10.8	9.8	2.44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-

SECCHI DISC DEPTH [illegible] 2.0

3.0													
3.1													
3.2													
3.3													-
3.4													

STATION Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	Total Organic Nitrogen µg at N.dm^{-3}	Total Nitrogen µg at N.dm^{-3}	Soluble Reactive Phosphor µg at PO_4^{3-}-P.dm^{-3}	Total Dissolved Phosphor µg at P.dm^{-3}	Total Phosphor µg at P.dm^{-3}	Chlorophyll a µg.dm^{-3}	Primary Production mg C.m^{-3}.h^{-1}	Extracellular Carbon Release percent
2.0	7.0	12.2	4.61	0.30	28.62	4.28	37.91	1.41	4.08	5.01	5.03	-	-
2.1	6.9	12.0	4.49	0.32	28.70	3.36	36.87	1.41	4.83	5.23	5.92	17.22	1.03
2.2	6.9	11.2	4.93	0.30	29.12	2.90	37.25	1.41	2.37	3.39	5.30	-	-
2.3	6.9	11.0	4.53	0.30	28.72	3.35	36.90	1.70	3.00	3.28	5.36	5.14	0.48
2.5	6.8	10.9	4.84	0.28	28.20	3.80	37.12	1.87	2.16	3.01	5.32	2.71	0.23
2.7	6.8	10.9	4.65	0.28	28.97	1.26	35.16	1.20	2.20	2.97	5.10	-	-
2.9	6.8	10.9	4.93	0.28	30.47	2.49	38.17	1.33	2.87	3.23	4.81	2.08	0.21
2.11	6.8	10.9	4.89	0.28	29.48	2.05	35.29	1.83	2.66	3.23	3.66	-	-
2.13	6.8	10.9	4.93	0.32	31.11	3.64	38.41	1.54	2.79	3.27	3.08	-	-
2.16	6.8	10.9	4.89	0.28	28.35	3.64	37.16	1.66	2.79	3.16	3.01	-	-

SECCHI DISC DEPTH (cm) 240

3.0													
3.1													
3.2													
3.3													
3.4													

DATE: 14 12 '84

STATION Depth m	Temperature °C	Dissolved Oxygen mg O_2.dm^{-3}	Ammonium µg at NH_3-N.dm^{-3}	Nitrite µg at NO_2^--N.dm^{-3}	Nitrate µg at NO_3^--N.dm^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2.0	4.5	13.2	3.77	0.59	22.99	[illegible]	[illegible]	1.04	[illegible]	2.22	[illegible]	-	-
2.1	4.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.66	3.38	5.50	[illegible]	[illegible]
2.2	4.5	10.5	3.91	0.63	30.94	[illegible]	[illegible]	[illegible]	3.54	4.51	5.21	-	-
2.3	4.5	10.5	3.85	0.64	30.40	2.23	37.12	1.25	2.00	3.29	3.31	3.32	.31
2.5	4.5	10.5	3.81	0.50	30.12	[illegible]	[illegible]	[illegible]	3.66	4.31	2.91	2.32	[illegible]
2.7	4.5	10.3	[illegible]	[illegible]	[illegible]	[illegible]	35.22	1.53	2.23	3.30	2.60	-	-
2.9	4.5	10.2	3.77	[illegible]	[illegible]	[illegible]	37.19	1.08	2.37	3.40	2.41	2.80	[illegible]
2.11	4.5	10.2	4.25	0.63	29.90	1.13	35.91	0.91	3.25	4.23	2.33	-	-
2.13	4.5	10.0	3.76	0.68	32.59	3.87	40.90	1.08	3.41	4.06	2.31	-	-
2.16	4.5	10.0	3.85	[illegible]	30.89	4.45	39.98	1.25	3.79	5.31	2.01	-	-

SECCHI DISC DEPTH (cm) 380

3.0													
3.1													
3.2													
3.3													

CURRICULUM VITAE

I. Identification

Name: Eduardo Mendes da Silva

Date of Birth: 13 January 1953

Place of Birth: Sao Paulo - SP

Nationality: Brazilian

II. Scholarship

High School: Colégio Estadual Duque de Caxias, 1964 - 1970, Brazil.

University: B.Sc. on Biological Sciences, Instituto de Biologia da Universidade Federal da Bahia, 1971 - 1975, Brazil.

Graduate Course: M.Sc. on Marine Biology, Marine Sciences Laboratories, University College of North Wales, Menai Bridge, 1979 - 1981, Britain.

Ph.D. on Biogeography at the Institute of Biogeography, Universität des Saarlandes, Federal Republic of Germany. Begin: 1982.

Supervisor: Prof. Dr.rer.nat. P.Müller